ARMY ORDNANCE

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Pledged to Industrial Preparedness as Our Strongest Guaranty of Peace

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THE ARMY ORDNANCE ASSOCIATION

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The Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace insurance" in this form is the foremost aim of the Army Ordnance Association.

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The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

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To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

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Fire Power

ARMY ORDNANCE

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Light Machine Guns

The Need for a New Automatic Infantry Weapon

By Brig. Gen. Earl McFarland*

THE experience gained in the World War led to a high appreciation of the tremendous importance of machine guns in combat. It was concluded that adequate machine-gun support must be available for almost every conceivable tactical situation. At the beginning of that war, machine guns were relatively heavy and cumbersome and decreased the mobility of battle troops. Today, however, the offensive operations in Europe have been characterized by ultra-rapid mobility combined with effective supporting fire power.

This is not a new principle: mobility and fire power are the two long-sought essential elements of combat. To a certain degree, these two qualities are mutually opposed; however, the recent operations in the Low Countries and in France show that an army may possess unbelievable combat strength and at the same time maintain a superlative degree of mobility. Combat strength requires the efficient use and employment of weapons. The skillful employment of machine guns often has resulted in obtaining superiority of fire in an otherwise hopeless situation.

The light machine gun became a part of the picture when the infantryman decided his chances would be improved if a weapon having the characteristics of the machine gun, even to a limited extent, could become a part of his squad equipment.

Although the general military requirements of a light machine gun long have been well established, the weapon itself has never yet reached a stage where the design of the gun has become typed or "frozen"; hence there are many and various weapons on the market and in the field which are listed as light machine guns. In order to arrive on common ground, it may be well first to state the present conception of what a light machine gun is. It is not a simple matter to write a concise definition. It is generally conceded that a light machine gun should have the following characteristics: It should be (1) capable of delivering an accurate fire at short and medium range and sustaining it over reasonable periods; (2) sufficiently light in weight so as not to decrease materially the mobility and maneuverability of the user; (3) capable of either automatic or single-shot fire; (4) reliable under the worst service conditions; (5) possessed of a mechanism easy to learn and economical to maintain in use; (6) suitable for all branches of the service; (7) capable of delivering fire on a fixed line.

It readily is seen that many of these requirements can be met approximately by several types of mechanisms and that more than one type of gun now in service may, in an emergency, be classed as a light machine gun. With the exception of the requirement of ability to shoot on a fixed line of fire, the basic requirements may be met by almost any automatic shoulder rifle in the military class. As a matter of fact, all the European weapons classed as light machine guns actually are automatic rifles. This type of weapon can be adapted to meet the last requirement by the addition of a bipod at the muzzle, a bipod and stock support, or a tripod.

ONE of the earliest light machine guns was the Lewis gun, used in very great numbers by the British and still a current model (Fig. 2). This weapon was heavy, weighing over twenty-eight pounds on its bipod, and had a rather strong trigger pull (twelve to fourteen pounds). It was a cumbersome weapon, not only because of its weight, but because of its 51-inch length. This World War gun was gas-operated and contained in its mechanism one novel feature—a small spiral clock-type mainspring located immediately forward of the trigger guard. The feeding of the cartridges was accomplished from a circular magazine drum affixed to the top of the gun. An attempt was made to provide forced cooling for the barrel by the provision of an aluminum radiator and a separate barrel jacket. The theory prompting this device was that the muzzle blast would induce a current of cool air flowing from breech to muzzle through the space between the barrel radiator and the jacket. Subsequent experiments at the Aberdeen Proving Ground have shown that this gun cools better when the outer jacket is removed and the heat from the barrel is permitted to radiate directly to the surrounding atmosphere. For ground use, the gun was equipped with a bipod. The Lewis gun, designed in the United States, has served Americans and Britishers and deserves high rank as a weapon of great usefulness and merit.

There also were used by the United States forces in France several other types of automatic rifles—light machine guns of those days—among which were the French Chauchat and the American Browning. The Model 1917 Chauchat automatic rifle was modified to caliber .30 from the French 8-mm. weapon. It was operated by recoil augmented by pressure of the gases against the muzzle face of the barrel. Although the 8-mm. French gun had been successful, the American Chauchat gun was far from satisfactory and was not popular with United States troops. It was replaced by the Browning automatic rifle as soon as this gun could be put into production. The Chauchat was an awkward-looking device, 46 inches long, weighing 20 pounds, and firing at a rate of 250 to 300 rounds a minute.

The Browning automatic rifle, Model 1918, after having been thoroughly tested under fire in the World War, is still used extensively and is highly regarded by our Army

* Assistant to the Chief of Ordnance and chief of the Military Service, Ordnance Department, U. S. Army.

FIG. 1. THE BROWNING MACHINE GUN, CALIBER .30, M1919A4

Although it has been improved by modification of several details during the last twenty years, the operating mechanism has remained unchanged. This rifle deserves more than passing notice. In appearance it resembles a heavy shoulder rifle. It is gas-actuated, the port connecting the barrel to the gas cylinder being about six inches behind the muzzle. The gas impinges upon a piston and drives it to the rear. The rear portion of the piston is connected to the slide which contains the hammer and which, in turn, is connected by a linkage to the bolt. Motion of the slide to the rear causes the linkage to withdraw the bolt lock and bolt from their seats and to extract the fired cartridge case. The empty case is ejected when its rim strikes the ejector. The new round is fed from below by the magazine (20-round capacity) and is forced into the chamber by the forward motion of the bolt. This forward motion is produced by the expansion of the recoil spring which is compressed when the slide moves to the rear. Locking of the bolt and striking of the firing pin by the hammer are accomplished by further forward motion of the slide. The mechanism is simple and its action positive; thus the probability of malfunctioning is correspondingly reduced.

FIG. 2. THE LEWIS LIGHT MACHINE GUN

So successful has this mechanism been that attempts to improve it have been few—the only modification being the reduction of the cyclic rate. In the standard gun, the operating parts never have been altered.

One of the first attempts to improve the Browning automatic rifle was the addition of a heavier, ribbed barrel to increase the heat radiation of the gun and thereby increase its capacity for sustained fire. Along with this change, the use of a muzzle bipod and a stock support afforded a more stable weapon, with the resultant increase in accuracy of fire. Thus modified, the weapon was known as the Browning machine rifle, M1922 (Fig. 4).

The use of the ribbed barrel has not been continued, but several improvements have since been made to the bipod and butt support. Thus, the present standard Browning automatic rifle, M1918A2 (Fig. 3) is essentially the same as the war-time gun plus bipod, butt support, and rate reducer. This now fulfills the requirements of the Infantry for a more stable mount and it is the standard light machine rifle for Infantry use.

THE Browning machine gun, caliber .30, M1917, as a recoil-operated, belt-fed, water-cooled weapon, is the type of ground machine gun used by the United States Army. With water, the weight is about thirty-seven pounds. While basically the same weapon as was adopted on our entrance into the World War in 1917, it has been improved in several minor details and is now classified as the M1917A1. The Browning tank machine gun, caliber .30, M1919, was developed for use in tanks. It is essentially the M1917 gun with a heavy 18-inch barrel instead of the 24-inch barrel and water jacket. This is now an obsolete type. However, this same tank gun was employed in the development of a weapon which would meet the Cavalry requirements for a belt-fed light machine gun. The modifications were minor, such as sights, back-plate assembly, stock, carrying straps, etc. A light tripod also was developed. The weapon was well adapted for Cavalry use, either for carrying in pack or for use on combat vehicles. The disadvantage was that the short barrel and resultant reduced muzzle velocity offered such limitations in effectiveness that further development was necessary.

Progressive developments resulted in the Browning machine gun, caliber .30, M1919A4, which is now the standard

FIG. 3. THE BROWNING AUTOMATIC RIFLE, CALIBER .30, M1918A2

ground gun and combat-vehicle machine gun of the Cavalry (Fig. 1). The weapon weighs twenty-eight pounds and is currently mounted on the 15-pound M2 tripod. The tripod has shown certain mechanical deficiencies, and modifications are being made to incorporate as many desirable features as practicable.

In Europe, progress in the development of the light machine gun has followed much the same course as in the United States. This weapon, with its capacity for a large volume of directed fire, has received much attention from all the major arms manufacturers and many types and models have been built. Among these may be mentioned the Madsen, Hotchkiss, and Bren.

The Madsen machine rifle (Fig. 6) is manufactured by the Danish Recoil Rifle Syndicate of Copenhagen, Denmark. This firm long has been known to the Ordnance Department. The rifle is actuated by a short-recoil mechanism similar in principle to that of the Browning machine guns. As the magazine is placed above the receiver it is necessary that the sights be not set directly above the axis of the barrel. Although resembling a rifle in outward appearance, this gun is ordinarily fired from a tripod mount. The tripod furnished by the Syndicate is entirely different, both in construction and in use, from those designed in this country. It is made of slender tubing and, as it gives the gun a high command, has a tendency to increase dispersion when the gun is fired. To reduce this dispersion, there has been incorporated a device which permits the gun to slide in recoil when fired. A Bowden flexible control is used so that the trigger may be reliably operated while the gun is in motion. An advantage of this type of mount is the ease with which it may be adjusted to various command heights and also to deliver antiaircraft fire.

The Hotchkiss light machine gun, manufactured in France, is another weapon which has been adapted from a World War gun. Originally a heavy machine gun, it has been redesigned to weigh, with its tripod, about eighty pounds (Fig. 7). Of this, the tripod accounts for about fifty pounds. Figure 8 shows the Hotchkiss 7.5-mm. machine rifle on a bipod mount. The gun itself weighs approximately nine pounds; the mechanism is of the traditional Hotchkiss type, being gas-operated. The gas impinges upon the front end of a slide which moves to the rear; this action causes the bolt to rotate and move rearward with the empty case. Feeding is accomplished on the forward stroke, the ammunition being furnished in strips or semiflexible belts—the former hold thirty rounds each; the latter consist of 3-round clips linked together. The cyclic rate of fire of this gun can be varied from 600 to 350 rounds per minute, while provision also is made for semiautomatic firing. The gun is air-cooled and has been provided with a means for quickly changing the barrel.

THE Bren light machine gun (Fig. 5), now being extensively manufactured in Great Britain, is of a type formerly produced at Brno, Czechoslovakia. It is of the automatic-rifle type, equipped with a bipod and folding butt plate. The mechanism is gas-operated and feeds from a 30-round magazine which is attached to the top of the receiver. The gun is a development of the old Berthier automatic rifle which was tested by the United States during the World War and of which a limited quantity were ordered but never delivered. The total weight of the Bren is about twenty-one pounds. Although the cyclic rate of the gun is about 550

FIG. 4. THE BROWNING MACHINE RIFLE, CALIBER .30, M1922

FIG. 5. THE BREN LIGHT MACHINE GUN WITH BIPOD AND FOLDING BUTT PLATE

rounds per minute, the actual ammunition consumption is more likely to be about 120 rounds per minute. A handle is attached to the underside of the stock so that the left hand may hold the stock down against the shoulder during firing. Another handle is attached to the barrel, both for carrying the gun and also as an aid when changing a hot barrel for a cool one. This changing of barrels can be done easily as the connection to the receiver is made by an interrupted thread.

CAREFUL consideration has been given to the formulation of military characteristics for a new light machine gun to meet, in one weapon, the requirements of both the Infantry and the Cavalry. A summary of these characteristics follows:

FIG. 6. THE MADSEN MACHINE RIFLE ON TRIPOD

Type and caliber.—Air-cooled, caliber .30, standard ammunition. It is essential that the weapon be air-cooled in order to obtain decreased weight as well as to eliminate the inherent difficulties of obtaining a proper coolant liquid in certain tactical situations. Standard caliber .30 ammunition must be used in order to avoid confusion in ammunition supply and in order to prevent an unruly, complex, small-arms ammunition supply system.

Rate of fire.—Selective automatic and semiautomatic, cyclic rate 300-350 rounds per minute. The selective feature of automatic or semiautomatic fire has been chosen in order that the weapon will be well adapted for various tactical missions. This item, coupled with a cyclic rate of 300-350 rounds, will permit accurate fire, conserve ammunition, and will not burden the lines of supply.

Weight of gun.—Not to exceed twenty-two pounds. The efficiency of an army in the field is lowered by fatigue. With the normal equipment which a soldier carries it is felt that a weight of twenty-two pounds will not cause undue fatigue. This weight is probably the maximum additional weight which a soldier can carry for a sustained period of time.

Type of feed.—Metallic belt. The use of metallic belts will reduce the problems of malfunctioning which are characteristic of the fabric belt when wet. Metallic link belts also insure that ammunition will be interchangeable for all guns.

Method of operation.—Not prescribed. In order that the designer may have his own choice in method of operation, it has been decided that this feature will not be stated specifically. The Army is interested principally in results, and the details necessary to accomplish those results are properly left to the ingenuity of the designer.

Barrel.—Front removable type. The front removable barrel has been specified in order to permit change of barrels without dismounting the entire weapon. The barrel must have sufficient weight to maintain five minutes of full-automatic fire using 100-round belts. In this firing there must not be excessive dispersion or keyholing. A sufficient barrel weight will insure maximum fire power within the specified weight limits of the weapon. When the barrel is removed, no part

FIG. 7. THE HOTCHKISS 7.5-MM. LIGHT MACHINE GUN ON TRIPOD

shall be longer than thirty inches—preferably twenty-eight inches. This will permit compactness and simplicity.

Length over all.—For convenience in packing and handling, an over-all length not to exceed thirty-eight inches has been specified.

Stability—Maximum stability and accuracy must be maintained. A stable weapon will not cause excessive dispersion.

Reserve power.—In order to insure reliable operation, the gun shall be capable of lifting a guided 100-round belt of ammunition between −30 and +80 degrees elevation.

Direction of feed.—In order to conform with existing guns and to simplify training of personnel, a feed from the left side has been specified.

Trunnion support.—The trunnion support is to be on the line of the firing reaction. This will insure maximum accuracy with a minimum weight of the mount.

Stock.—The stock shall be single pistol-grip type with a pull-type trigger. This also conforms with existing matériel and simplicity in training of personnel.

Sights.—As a result of past experience, the sights selected are to be the same as those on the Browning automatic rifle, M1918A2.

Mount.—In order to permit fixed and accurate fire in any direction, the mount is to be of a tripod type. The total weight of the mount is not to exceed eighteen pounds.

Command height of gun on tripod.—In order to prevent hostile ground observation, a low silhouette is essential. The command height of the gun is to be approximately eighteen inches. This height will provide a low silhouette and also permit sighting over grass and various other terrain objects.

Gun and mounting.—The gun and mounting are to be so designed that the complete unit will be capable of use with fixed fire and with mechanical elevation and traverse.

Traverse.—Traverse is to be 360 degrees in order that all-around effective fire may be obtained. In order to obtain fixed accurate fire, a slow-motion traverse has been specified. This slow-motion traverse is to permit accurate laying from 100 mils left to 100 mils right.

Elevation.—A free elevation of at least 600 mils is required. For the same reasons given for slow-motion traverse, a slow-motion elevation of 50 mils to a depression of 50 mils is required. The free depression must be at least 540 mils. With these limits it should be easy to bring the fire upon almost any target of opportunity.

Traverse support.—The gun and mount must be easily maneuverable and portable by hand transport. This will insure rapidity in moving from point to point.

FIG. 8. THE HOTCHKISS 7.5-MM. MACHINE RIFLE, WITH SPARE BARREL

The information on the following pages has been mailed to individuals and firms known to be interested in the design and development of the light machine gun. Additional copies are available and may be obtained by making application to the Chief of Ordnance, Washington, D. C.

Light Machine Gun Characteristics

INFORMATION FOR INVENTORS

THE War Department is interested in obtaining a light machine gun and mount having characteristics as follows:

Type and caliber.—Air-cooled, caliber .30, standard ammunition.

Rate of fire.—Selective automatic and semiautomatic fire. Cyclic rate, 300-350 shots per minute.

Weight of gun.—Not to exceed 22 pounds.

Type of feed.—Metallic belt, capable of being used in existing Browning machine guns.

Method of operation.—Any method of operation which will permit meeting all the requirements of functioning and stability.

Barrel.—Front removable type. When barrel is removed no part should be longer than 28 inches, and 30 inches is the maximum allowable. Barrel shall have sufficient weight to maintain 5 minutes fire at full-automatic rate, using 100-round belts, without excessive dispersion or keyholing.

Length over all.—Not to exceed 38 inches.

Stability.—Maximum stability and accuracy consistent with weight and command height specified shall be sought.

Reserve power.—Gun shall be capable of lifting a guided 100-round belt between −30 and +80 degrees elevation.

Direction of feed.—From left side.

Trunnion support.—On line of firing reaction.

Stock.—Single-stock pistol grip, pull-type trigger.

Sights.—Sight same as 1918A2 Browning automatic rifle.

Mount.—Tripod type; weight of mount not over 18 pounds. Gun and mounting to be so designed that the complete unit will be capable of use with fixed fire and with mechanical elevation and traverse.

Command height of gun on tripod.—Approximately 18 inches.

Free traverse.—360 degrees.

Slow-motion traverse.—100 mils left; 100 mils right.

Slow-motion elevation.—50 mils elevation; 50 mils depression.

Free elevation.—At least 600 mils.

Free depression.—At least 540 mils.

Facilities for hand carriage.—Handle.

It is planned that competitive tests of the above-described matériel will be held during the month of October, 1941, at a place to be designated by the Chief of Ordnance. It is not required that a mount shall be submitted, but this is desirable in order that the design of gun and mount be properly coördinated. In the event that the designer does not desire to submit a mount, provision should be made for mounting his gun on the caliber .30 M2 tripod. At least one extra barrel and such replacement parts as, in the judgment of the designer, are required to complete the tests, should be submitted with the gun.

Designers and manufacturers having light machine guns and tripod mounts therefor which they desire to submit for the competitive tests should address an application requesting such tests to the Chief of Ordnance, United States Army, Washington, D. C., prior to September 1, 1941. Any matériel accepted for test will remain in the hands of the Ordnance Department until the conclusion of the tests; however, ample opportunity will be afforded for replacement of parts if required. The acceptance of matériel for test will not obligate the Government either to purchase the matériel or to reimburse its owner for wear and tear or damage.

FOR the guidance of those interested in perfecting a design of this matériel, the following additional information is furnished: The matériel should be simple, rugged, and compact. *Reliability of functioning and ease of manufacture should be guiding factors in design.* A minimum number of parts is desirable; however, reduction in number of parts should not be obtained by unduly complicating the design of individual components. Parts which may require field replacement or cleaning should be designed with a view to ease of dis-

mounting and reassembling, preferably requiring no other tool than the service cartridge. The mechanism should be well protected from the entrance of rain, sand, or dirt.

The gun must be so designed as to preclude the possibility of injury to personnel due to premature firing; that is, firing before the action is in the normal firing position. In addition, it must have a manually operated safety device to prevent accidental discharge.

The use of special lubricants not readily obtainable should not be necessary to the proper functioning of the gun, and the gun must function properly without lubrication of the ammunition. The number of special tools required for adjustment, dismounting, assembly, or replacement of parts, should be a minimum. The trigger pull, measured at the middle point of the bow of the trigger, should be not less than six or more than ten pounds.

Ammunition and other matériel required by designers will be sold at cost in accordance with existing laws and regulations. Applications to purchase should be addressed to the Chief of Ordnance. No Government funds will be available for the development of private models prior to or during this test.

ALL weapons and mounts submitted will be examined and tested in accordance with the program below. Ammunition for the tests will be furnished by the Government.

TEST I.—The items undergoing test will be disassembled and an examination and photographs made of all working parts. The number and names of all parts and the types of springs will be recorded. The weights and major dimensions will be recorded. Comment will be made on the simplicity of design and ease of manufacture.

TEST II.—The time, also the number and kinds of tools, required for each of the following operations will be recorded: disassembly, assembly, adequate cleaning.

TEST III.—Two rounds of cartridge, caliber .30, high-pressure test, will be fired singly. The gun mechanism will be examined and the headspace measured before and after test.

TEST IV.—Ten targets of 20 rounds each will be made at 300 yards. Five of these targets will be fired semiautomatically and five automatically, the gun being mounted on the tripod submitted or otherwise as may be necessary.

TEST V.—There will be fired 30 rounds for the determination of instrumental velocity.

TEST VI.—The gun will be fired 100 rounds semiautomatically to observe general behavior and functioning. The gun will be fired 300 rounds automatically to observe general behavior and functioning. The gun will be fired 300 rounds, both semiautomatically and automatically, the mechanism being changed from one type of operation to the other at least 10 times during this firing.

TEST VII.—To test the action of the mechanism with increased and reduced powder pressures, 25 consecutive shots will be fired with the cartridges loaded to give a powder pressure of 55,000 pounds per square inch and 25 loaded to give a powder pressure of 38,000 pounds per square inch. This test will be conducted at both the automatic and semiautomatic settings.

TEST VIII.—The gun will be fired 10,000 rounds automatic for endurance at the rate of 100 rounds per minute. The barrel may be cooled and parts oiled without disassembling after each 500 rounds. The entire mechanism may be disassembled, cleaned, oiled, etc., after each 2,000 rounds. All malfunctions, breakages, and replacement of components, together with the total firing time, time for replacement or correction of parts, etc., will be recorded. The cyclic rate of fire will be taken at the beginning of each 500 rounds. The general working of the gun then will be examined. The headspace will be measured after each 2,000 rounds of this test. Before the endurance test, measurements will be taken of the length of the bolt and all shoulders which sustain powder pressure. These measurements will be repeated after the endurance test. The reserve power will be tested at the beginning of each 1,000 rounds by weighing the belt pull which will stop the gun.

TEST IX.—With a new barrel, a test will be made to determine whether the gun will meet the requirements of five minutes full-automatic fire mentioned above. This requirement is based on the actual firing of 200 rounds during the first minute and 120 rounds during each succeeding 4 minutes.

TEST X.—With the mechanism closed and both ends of barrel tightly corked, the gun will be exposed, in a box prepared for that purpose, to a blast of sand for two minutes and then removed. The surplus sand may be removed by blowing thereon, jarring, or wiping with the bare hand only. There then will be fired 500 rounds, automatic fire.

Such additional tests as may be considered desirable, including tests by the Infantry and Cavalry, will be made.

Ordnance Research

The Department's Use of Technical and Scientific Facilities

By Col. G. M. Barnes*

THE rapid progress which is made in industry through the use of research is so well recognized today that most of our large industries liberally support such activities. It is natural, therefore, that scientists, engineers, and industrialists should desire to know what the War Department is doing to keep pace with scientific and commercial developments. Many are asking whether such developments are reflected in the designs of the munitions which are being procured by the War Department in considerable quantities under the emergency programs. Has the Army adequate research facilities and personnel, and is advantage taken of the vast research resources and organizations available in this country?

The War Department is handicapped by the requirements of secrecy in its desire to keep the people of this country informed as to its activities in strengthening national defense. In many cases it is necessary to keep confidential the War Department's research-and-development projects.

The business of providing the Army with equipment of all classes is subdivided principally between six supply arms and services; namely, the Quartermaster Corps, Medical Corps, Corps of Engineers, Signal Corps, Chemical Warfare Service, and the Ordnance Department. These organizations are engaged in the development of the classes of items assigned to them, and most of them operate research laboratories. The Signal Corps has its laboratory at Fort Monmouth, N. J., which is devoted to the development of signal equipment. The laboratories of the Chemical Warfare Service are at Edgewood Arsenal, Md., where chemicals and material used by that branch of the service are investigated. The Quartermaster Corps has its subsistence laboratory in Chicago; the equipment laboratory of the Medical Corps is located at Carlisle Barracks, Pa., and the Corps of Engineers carries on experimental work at Fort Belvoir, Va. A complete discussion of all the War Department activities would include the work being carried on by these services. This article, however, is limited to the research activities of the Ordnance Department.

The Ordnance Department of the Army is charged with responsibility for the design, development, procurement, storage, and issue of the weapons used by the Army. In other words, the Department has to consider some 1,200 separate important items, together with approximately 250,000 components in the general categories of cannon and their mounts, rifles, pistols, machine guns, fire-control instruments, tanks, combat cars, scout cars, bombs, pyrotechnics, and all types of small-arms and artillery ammunition. Most of these items are noncommercial in character and many research-and-development problems are involved which are not included in the activities of commercial laboratories or civilian scientific and engineering organizations.

Therefore it has been necessary for the Ordnance Department to create and maintain research-and-development facilities and personnel to work on its special problems. However, it has been the policy of the Department for many years to maintain close contact with other agencies of the Government engaged in research-and-development work and to utilize the services of the laboratories of large commercial and educational establishments in the United States. To further insure that close contact is maintained, special committees of civilian engineers, such as the Ordnance Advisory Committee of the Society of Automotive Engineers, have been organized to consider the problems of the Department.

Instead of using one large research laboratory to deal with these problems, it has been found desirable, in view of the diversified character of the work, to have a number of laboratories which specialize along particular lines. The Department operates six arsenals which combine manufacturing and laboratory facilities. Each arsenal is engaged in research and development of the material assigned to it. A proving ground for testing completed experimental models is maintained at Aberdeen, Md., which is also the center for ballistic research. The manufacturing facilities of the arsenals have been designed to fit the products of these establishments and are used in the construction of experimental types of equipment as well as manufacture in some quantity.

The basic research is confined, principally, to that carried out in fields not overlapping those in which the scientific men of the country are working. Naturally, most of the activities of the arsenal laboratories are directed toward technical research with the primary purpose of applying scientific principles to the solution of specific problems of ordnance engineering.

IN 1776, Col. Henry Knox, one of General Washington's commanders, recommended: "That there shall be one or more capital laboratories erected at a distance from the seat of war, in which shall be prepared large quantities of ordnance stores of every species and denomination. That at the same place a sufficient number of able artificers be employed to make carriages for cannon, of all sorts and sizes, ammunition wagons, tumbrils, harness, etc. That as contiguous as possible to this place a foundry for casting brass, cannon, mortars, howitzers, be established upon a large scale." The logic of Colonel Knox's recommendation found favor, and on February 11, 1777, he was directed by General Washington to go ahead with the work at Springfield. On February 20, 1777, the Continental Congress approved the action. The undertaking was to be financed by the Council of Massachusetts Bay. The first work done was the loading of cartridges. This was the beginning of Springfield Armory and the whole chain of Army arsenals.

The manufacture of small arms began at Springfield Armory the year following the passage of the act of Congress establishing it and has never ceased since that date. During the four years of the Civil War, 1861-1865, more than 800,000 muskets were manufactured in this arsenal. Later, after years of experimentation and test, the United States Army adopted the U. S. rifle, Model 1903, which was

* Assistant for Engineering, Industrial Service, Office of the Chief of Ordnance. Colonel, Ordnance Department, U. S. Army.

developed at this arsenal and which, until the advent of the new semiautomatic rifle, was the standard weapon for the Army, Navy, Marine Corps, National Guard, and all contingents of the Army of the United States. During the World War, the daily production of rifles with their spare parts and other appendages, assembled, packed, and turned into store for shipment, reached the total of 1,500 per day. Throughout the years, Springfield Armory has contributed greatly to the idea of interchangeable manufacture which finally has become one of the outstanding characteristics of the American system of mass production.

One of the notable accomplishments of the Springfield Armory of recent years has been the development of the new semiautomatic shoulder rifle M1. The work on the development of this rifle has extended over a period of approximately twenty years. During this time, a very large number of semiautomatic rifles designed by the citizens of foreign countries, as well as those developed in the United States, have been tested.

The rigid military requirements for the semiautomatic rifle present a very difficult problem. The rifle must have all the desirable features of the Springfield M1903 which was considered the world's best military rifle. It also must have a semiautomatic feature, and this must be added with a minimum of additional weight. In this development, close contact has been maintained with engineering societies and commercial laboratories in order that full advantage might be taken of recent improvements in materials and methods of manufacture. The result has been the standardization of the rifle which now is being manufactured for issue to the United States Army. The Regular Army organizations which have recently tested the semiautomatic rifle are very enthusiastic over its performance. Through its use, the fire power of the infantry soldier has been increased approximately 2½ times.

Springfield Armory and Colt's Patent Fire Arms Manufacturing Company, under the supervision of the Office of the Chief of Ordnance, are continuously collaborating on developments and improvements of machine guns. This cooperative effort has been most effective in securing machine guns of the highest quality for both the Army and the Navy.

WATERTOWN ARSENAL, established in 1816, is located at Watertown, Mass., and is engaged in the manufacture of gun forgings and centrifugal castings, railway, seacoast and antiaircraft artillery. The metallurgical laboratory of the Ordnance Department is located at this arsenal which is the center for general and ferrous metallurgical research. This was so even before steel became an important factor in ordnance construction. In the first half of the ninteenth century, ordnance development centered around the cast-iron industry, just as today the munitions program is built around the steel industry. From 1825 to 1850, a number of private foundries were engaged almost exclusively on ordnance work, and they did much to improve the quality of cast iron and the technique of manufacture. Their work usually was performed in collaboration with Ordnance officers of the Army and Navy engaged in similar lines of endeavor.

In 1849, Lieutenant (later General) T. J. Rodman, who did much of his work at Watertown Arsenal, invented a revolutionary method for casting cannon which gave compression at the bore, improved metal structure, and increased the life of cannon eleven to twenty times. This invention had a profound influence on metallurgical thought in this country and abroad. The principle of initial compression at the bore has been accepted as a fundamental feature of design since General Rodman's time.

Because of the fine reputation of American cast-iron guns, it is not surprising that when, after the close of the Civil War, steel began to be considered as a possible substitute, the friends of cast iron rallied to its defense. The controversy over the relative merits of steel and cast iron reached Congress and resulted in the appointment of a board of Army and Navy officers and civilian experts and the construction of a machine for testing the strengths of metals. This machine, designed and constructed by A. H. Emery and installed at the Watertown Arsenal in 1879, is capable of testing accurately the strength of a horsehair or of a steel bar requiring an 800,000-pound load to break. So carefully did Emery design, that the original machine, with unimpaired delicacy, is still in almost daily use for official and private tests. It is the prototype of a long series of hydraulic testing machines that have been developed since.

The law authorizing the machine provided that it should be available for service to industry and that reports of tests should be made to Congress. The reports, entitled "Tests of Metals," were published annually from 1882 to 1918 and have been sources of information for scientists and engineers and have been quoted extensively in textbooks and technical papers. They also have served to give authoritative information as to the merits of steel and in this way have contributed to the development of the steel industry. In fact, the decision to adopt steel for armament was based on these reports. This decision inaugurated the industry, and the rigid service requirements later demanded were largely responsible for improvements in steel which have led to the preëminent position which this great industry now occupies.

Watertown Arsenal's contributions to early developments in metallurgy have been recognized as important. Later contributions have been no less so. Some more-recent achievements have been:

(1) The development of the centrifugal-casting method for the manufacture of gun tubes. This has been a revolutionary step in gun construction resulting in saving of time and cost. (2) The development of the cold-working method of gun manufacture. In this process, internal hydraulic pressures as great as 125,000 pounds per square inch are employed which greatly increase the strength of the gun tube or cylinder by overstraining the bore and by leaving the inner annulus in a state of compression. (3) The development of molybdenum tool steels. The use of these steels in industry has rendered tungsten, for which molybdenum is substituted, much less significant strategically. (4) The use of radiography as a method for inspection and control in the manufacture of castings and welds. This method of nondestructive testing has greatly facilitated the development of welding and casting processes and has been widely adopted by commercial industry. (5) The development of the welding process for use in the fabrication of gun carriages. This has resulted not only in weight reduction but also in economy, improvement of design, and feasibility of manufacture. (6) The development of quantitative spectrum analysis for chemical control of foundry products. (7) The development of impact testing, particularly with regard to high-velocity ruptures. (8) The development of macro-etching for the inspection and control of centrifugally cast guns and for the

inspection of forgings. The development of this method of macro-etching at the arsenal has greatly facilitated experimental and production work and has had important applications in industry.

The above are indicative of the nature and importance of activities that have been pursued. Most of these have had applications in commercial industry.

Problems occupying the attention of the laboratory touch most of the phases of physical metallurgy. They cover such items as plasticity of metals, improvements in foundry practice, methods of measuring temperatures of liquid-steel baths, improvement of armor plate and armor-piercing ammunition, improvements in welding, improvements in the surfacing of metals, the nature of gun erosion, spectrum methods for gas analysis of steel, basic factors involved in shell fragmentation, development in instruments and technique for examination of metals, and others.

ROCK ISLAND ARSENAL celebrated its seventy-fifth birthday in 1938. The reservation embraces the entire island of Rock Island, comprising approximately 900 acres, situated in the main channel of the Mississippi River between Davenport, Iowa, and the adjoining cities of Moline and Rock Island in Illinois. The construction of the arsenal was authorized in 1862, the intention at the time being to construct merely a small arsenal for storage and repair rather than one for general manufacturing purposes. General Rodman conceived and developed the ten original stone shop buildings as they stand today. These remained comparatively unequipped until the Spanish American War, when the arsenal assumed the burden for supplying the bulk of the Army's requirements for munitions. A much greater expansion involving new buildings and equipment took place during the World War when munitions valued at more than a hundred million dollars were manufactured.

The research problems of Rock Island Arsenal are those connected with the development of materials and methods used in the manufacture of mobile artillery, gun mounts, tanks and other automotive equipment, machine guns and their mounts, and a great variety of accessory equipment and supplies. The arsenal laboratory is equipped and staffed primarily as a control laboratory for making acceptance tests on materials, for checking manufacturing processes and for solving problems incident to production of the foregoing material. Such investigations, together with problems assigned the arsenal by the Chief of Ordnance, often lead into basic and technical research which is conducted in the arsenal laboratory when it is apparent that the desired information is not available from other sources. Such research has been conducted in connection with the development or improvement of armor plate, steel castings, rubber components used in tracks of track-laying combat vehicles, oils, greases, and packing rings for gun-recoil mechanisms, paints, rust preventives, cleaning materials, and various other items. Complete investigation of these from the standpoint of present and possible future employment by the Ordnance Department has been necessary because the particular applications are not duplicated in commercial industry.

Much of the work of the Rock Island Arsenal laboratory results in the development of new sources of supply of satisfactory material. A material as originally used may be capable of manufacture by only one industrial concern and then on a more or less experimental basis. By analyzing a material from its origin to its final use, the laboratory has been able to suggest improvement and, most important of all, to aid in developing a product which can be furnished by several manufacturers.

Research leading to the development of improved materials and methods for preserving ordnance material in storage has been of utmost importance. The materials and methods used by industry, while satisfactory for the normally short storage periods encountered, are wholly inadequate when applied to ordnance material which must be serviceable after years of storage.

The research problems assigned to the arsenal and generally continued from year to year include the investigation of satisfactory substitutes for strategic materials such as mica, rubber, hides, and tin. Distinct progress on these investigations has been made. Also, programs for the improvement of the Belleville and helical springs used in gun-carriage construction are carried on continuously. This problem involves the investigation of various spring steels, methods of fabrication, their subsequent heat treatment, and their fatigue life under laboratory conditions.

THE military necessity for a depot in the vicinity of Albany, N. Y., was made apparent when the second war with England showed the need for a more thorough protection of the Canadian border from invasion. This necessity was met by the establishment of Watervliet Arsenal. Construction proceeded gradually from 1813, when the original arsenal of twenty buildings was erected, through the Civil War when the Army gun factory was established. The arsenal was further expanded during the war emergencies of 1898 and 1918. Among the early types of cannon manufactured at Watervliet was the 3-inch wrought-iron gun which was constructed by wrapping a piece of boiler iron around a wrought-iron mandrel, heating the resulting cylinder to a welding heat, and then passing it through rolls, after which it was bored, rifled, and turned. The present equipment at Watervliet Arsenal permits the manufacture of all calibers of guns from the smallest field howitzers to the great 16-inch seacoast guns weighing 350,000 pounds.

The arsenal has seen the evolution of the cannon from the muzzle-loader to the modern high-powered weapon. Many radical changes have taken place—from single-piece gun tubes to assemblies of built-up and wire-wrapped guns. A recent change in design has been the reversion from the built-up gun to the single-piece type, in the case of small- to medium-caliber guns. This has been brought about by the increased strength of modern steels and the further augmentation of strength by means of the cold-working process.

The life of guns has been greatly increased by means of the loose liner. With antiaircraft guns especially, the wear on the rifling is very great because of high muzzle velocities. A change of liners becomes a simple operation, and in time of war fewer guns would be kept out of service since the renewal of a loose liner is only a matter of a few hours, compared with about six weeks' time formerly required to replace a shrunk-in liner.

Recent projects at Watervliet have included experimental work on hones for long cannon bores, various types of plating for gun surfaces, development of breech operating pads to hold powder pressures up to 38,000 pounds per square inch, and similar noncommercial activities pertaining to the manufacture of cannon.

The land on which Frankford Arsenal is situated was obtained by transfer from John, Thomas, and Richard Penn, to Alexander Hamilton in May 1772, at a price of one shilling, sterling, for each one hundred acres. As the reservation contains about ninety-one acres, its cost was less than one shilling. Frankford Arsenal was established under the general authority which provided that depots be erected in various parts of the country, as contained in an act of Congress in 1815. The work of constructing the arsenal proceeded gradually until the war with Mexico, at which time it was engaged principally in repair work, interspersed with certain manufacturing activities. The archives show the production of such items as flint caps, grapeshot, 12-pounder strapped shot, quick matches, eprouvette beds, sabots, vent punches, and bombazette cartridges. During the war period, from April 1917 to November 1918, it expended over forty million dollars in its manufactures.

Frankford Arsenal deals principally in problems connected with the development of small-arms ammunition, artillery shells, and fire-control instruments for all classes of artillery. At present, some of the more pressing problems in the ammunition-research department are the development of high-velocity armor-piercing ammunition for caliber .30 and .50 rifles, core steel of improved impact qualities, and improvements in the shape of the core of bullets to give maximum efficiency.

The fire-control laboratory conducts research in the fields of optics, acoustics, electronics, and the mechanics of various types of computing mechanisms. The research work in optics has been concerned currently in the design of optical elements suitable for fire-control instruments with a view to reducing, at the same time, the number of different types of optical glasses required. This laboratory includes an acoustic laboratory for the development of aircraft listening devices. With the advent of the complicated fire-control systems for antiaircraft artillery, the complexity of fire-control problems has increased. The automatic transmission of data required by director control of antiaircraft guns has introduced many problems concerning these systems.

IN 1879, Congress made an appropriation for the purchase of a powder depot and for erection of suitable buildings. The present location near Dover, N. J., was selected by a board of officers, and five tracts of land, consisting of about two thousand acres, were purchased. In 1880, the Secretary of War designated the reservation as the Picatinny Powder Depot. The first phase of the development of the arsenal extended to the year 1892, and the history of the depot was one of gradual construction with the ultimate idea of an establishment for the storage of powder. The second phase of the construction of Picatinny Arsenal began when projectile sheds and nitrate buildings were erected. A year later a plant was installed for filling projectiles with maximite.

The third phase of the arsenal's development began in 1906 with the erection and equipment of a powder factory. No great expansion took place during the World War; however, an organization for research-and-development work concerned with explosives was established and new laboratory facilities provided. In 1926, the explosion of the nearby Naval Depot at Lake Denmark almost completely destroyed the arsenal. The last phase in its development has been from the time of this explosion to the present, during which period the facilities have been completely rebuilt and expanded.

This arsenal is now the center of the design and development of all types of ammunition, except those mentioned in connection with Frankford Arsenal. Ammunition items such as time- and base-detonating fuzes are noncommercial, and this work must be performed principally by the Ordnance Department. However, close contact is maintained with all commercial companies engaged in similar lines of work. In designing an ammunition item, special consideration must be given, not only to dependability in functioning, but also to simplicity, adaptability to quantity production, ability to withstand transportation and handling in the field. Some of the problems now current include the development of mortar ammunition requiring close coöperation with commercial concerns working on the die-casting of metals; the development of shell suitable for various types of artillery projectiles, and the development of heat-treatment processes to obtain better shell fragmentation. There are many problems connected with the development of primers, demolition bomb bodies, bomb mechanical time fuzes, low-altitude bombs, burster systems, problems of land mines, pyrotechnics, flares for the Air Corps, ground and air signals, and bombardment flares. There are many additional problems concerning igniter systems and fuze systems to obtain various types of action.

Basic and technical research is constantly in progress in connection with the development of substitute explosives, development of fuze powders, tracer and primer mixtures, illuminating compositions, new explosive compounds, and substitutes for strategic materials used in connection with the manufacture of ammunition. A continual effort is made to keep abreast of the new products and processes of the chemical and process industries so that application of these to military problems may be made if practicable. Microscopic studies of the structure of nitrocellulose gels, specific surface of nitrocellulose fibers after treatment, rate of burning of colloided propellants, speed of detonation of high explosives, and fundamental studies on the ignitability of explosives, are now in progress.

THE ABERDEEN PROVING GROUND, established in 1918 and occupying some 24,000 acres, is essentially a laboratory. It includes a number of subsidiary laboratories as follows: (1) the gun and ammunition testing laboratory, (2) the automotive testing and research laboratory, and (3) the ballistic research laboratory.

The function of the gun and ammunition testing laboratory is to test under carefully controlled conditions guns and ammunition of new design and guns and ammunition of standard types manufactured by arsenals and industry. In connection with nearly all such tests, various types of measurements are made, such as the velocity of the projectile, the pressure in the gun, the recoil velocity of the gun, the time of flight of an antiaircraft shell, the coördinates of the point of burst, etc. Special measuring instruments of great refinement have been developed for this purpose and improvements constantly are being made.

The automotive laboratory tests pilot models, standard tanks, and track-laying vehicles used in mechanized warfare. The laboratory equipment includes dynamometers and apparatus especially developed for this work. Traction dynamometers are used in the development of tracks and vehicle suspensions, and equipment is available for measuring the rolling resistance of all types of vehicles. Permission to use these facilities frequently is sought by industrial concerns.

The research being conducted here on tracks, suspensions, and steering of high-speed track-laying vehicles is the only such activity in our country and is made possible by much especially developed equipment not available elsewhere. All tanks and most other fighting vehicles are of a highly specialized design and consist of components not available commercially or not available in such large or special forms. Research in armor plate and in rubber are two important elements of this work. The use of radial air-cooled engines in automotive vehicles and the use of rubber tracks for high-speed track-type vehicles are developments of the Ordnance Department. There is at Aberdeen the largest automotive traction dynamometer believed available in the United States and a larger one is under manufacture.

The functions of the ballistic research laboratory are the conduct of basic and technical research in exterior and interior ballistics and related subjects, including the development of ballistic instruments and the construction of firing tables for artillery projectiles and bombs. In view of the special equipment, such as guns, firing ranges, and instruments, required for research in ballistics, the Department realizes that it must depend largely upon its own efforts for advancement in this field which is of fundamental importance in the design, development, and scientific use of guns, projectiles, and bombs. A very considerable increase in expenditures in this field has been made in recent years and a new laboratory building to house research activities in ballistics is under construction.

Since the World War, considerable contributions to ballistics have been made by the laboratory. Among these are the measurement of the system of aërodynamic forces acting upon a considerable variety of projectile shapes at speeds varying from 500 to 3,500 foot seconds, the recording of pressure waves in the chambers of guns, the discovery of the causes of the waves and methods of eliminating them, and the development of new types of instruments to measure velocity, pressure, time of flight of projectiles and the refinement of existing types.

The contributions mentioned have been of great practical value in the design of new projectiles, the design of new types of propelling charges to give greater precision in muzzle velocity, and in providing for more accurate measurements in the tests of material.

The information concerning the forces acting upon projectiles has been utilized in the construction of firing tables of greater precision. To facilitate the calculation of the trajectories upon which such tables are based, the laboratory installed one of the four Bush differential analyzers in the country. The analyzer occasionally has been used to calculate trajectories for the Navy Department. Of course there is a rather complex theory underlying the calculation of the trajectories of bombs and projectiles. If the missiles are to hit their mark, it is essential that the theory on which the firing tables are based be correct. Refinements of considerable importance have been introduced in recent years.

One of the important features of the firing tables is the estimate of the dispersion in range and deflection to be expected under various firing conditions. In connection with the preparation of such estimates, a considerable amount of research in statistical theory has been done. This has led to important results concerning the distribution of the total dispersion and the estimation of the probable error from successive differences. Increasing attention is being given to the application of statistical methods in formulating procedures for the more efficient sampling of the large stocks of war-reserve ammunition.

DURING the World War, serious delays were encountered in obtaining quantity production of ordnance due, in part, to the impossibility of securing proper gages for controlling the accuracy of manufacture and the interchangeability of parts between plants manufacturing the same items. Gages to determine the conformity of manufactured material to drawings and specifications governing its inspection for acceptance could not be procured in sufficient quantities in time to prevent these delays. When the war ended, the Ordnance Department found itself in possession of approximately half a million Government-owned gages and a full realization of the importance which proper gaging plays in war manufacture. One of the prime purposes of gages is to transfer the skill of measurement from the workman or inspector to the gage, thus making possible the use of relatively unskilled labor as inspectors.

In order to control tools, gages, and measuring instruments and to insure that they are within the proper dimensions before and during continuous use, gage laboratories were established at the six manufacturing arsenals referred to, and all gages on hand at the end of the last war pertaining to the material manufactured at each arsenal were sent there for checking, proper classification, and storage.

The Ordnance Department also has had a definite gage policy for building up its stocks of inspection gages for new items and, to a limited extent, manufacturing gages for certain types of critical ordnance matériel. In addition to the six arsenal laboratories, gage laboratories in each of the Ordnance districts have been established (without expense to the Department, except for equipment) at the following educational institutions: Washington University, St. Louis, Mo.; Stanford University, Stanford, Calif.; University of Michigan, Ann Arbor, Mich.; New York University, New York, N. Y.; Georgia School of Technology, Atlanta, Ga.; Carnegie Institute of Technology, Pittsburgh, Pa.; University of Cincinnati, Cincinnati, Ohio; Case School of Applied Science, Cleveland, Ohio; Armour Institute of Technology, Chicago, Ill.

These gage laboratories, in addition to their function in the dimensional control of tools and measuring instruments which will be used in the production of ordnance in time of war, are used in time of peace to train personnel, both civil and military, in the use of precision measuring equipment. It thus is hoped by dimensional control to insure that the first items of matériel produced under war contracts will be correct from the standpoint of tools, fixtures, and gages. After initial production has been successfully inaugurated, subsequent mass production will be controlled through the periodic checking of facilities by these laboratories. The importance of these gages to prompt production cannot be overstressed since without them the tooling up for manufacture of parts cannot be completed.

Close liaison is maintained between the various departments of the Navy and its research laboratories whose work lies more closely parallel to that of the Army than is the case with commercial laboratories. Likewise, the U. S. Bureau of Mines coöperates with the Ordnance Department on explosives problems. During the war, the U. S. Bureau of Standards contributed greatly to the national defense by developing

for the War and Navy Departments the manufacturing processes for military optical glass. Prior to the World War, all high-grade optical glass used in military instruments was obtained from Germany.

A number of committees have been appointed by the War Department from time to time to assist the Ordnance Department in the solution of some of its problems connected with research. A metallurgical advisory board consisting of eleven outstanding civilian metallurgists, has worked with the metallurgical laboratory at Watertown Arsenal for many years. It has been of great assistance to the Department in the development of armor plate, special steels for guns, and similar metallurgical problems.

Another committee of civilian engineers which has been meeting with the Ordnance Department for a period of over twenty years is the S.A.E. Ordnance Advisory Committee. The membership of this committee, which is headed by Col. H. W. Alden, chairman of the board of the Timken-Detroit Axle Company, includes automotive engineers of outstanding ability engaged in the commercial development of trucks, tractors, and similar automotive vehicles. This committee meets from time to time to advise the Chief of Ordnance concerning his research-and-development programs for combat vehicles. At these meetings, the projects for research are analyzed. Recent commercial developments in the automotive field are brought to the attention of the Department by the committee. For example, one of these new developments is the fluid flywheel and the automatic transmission. As the result of a recent meeting of this committee, the Department has been able to obtain these devices for test in a combat tank. In this manner, the Department is kept in constant touch with the most recent accomplishments of the commercial laboratories throughout the automotive industry, and is able to take prompt advantage of new discoveries.

Another committee is the S.A.E. Rubber Products Subcommittee. The chairman of this subcommittee is J. E. Hale, chief engineer of the tire division, Firestone Tire & Rubber Company. It operates in a manner similar to the Automotive Advisory Committee, and keeps the Ordnance Department fully advised as to progress in rubber engineering. Some of the problems considered by this committee are the application of rubber blocks to tank tracks, rubber joints for track pins, rubber insulation to reduce noise of sprockets and bogie wheels, rubber linings for the interior of tanks, types of bullet-proof tires and tubes, and similar problems pertaining to the field of ordnance.

The Department obtains important assistance from commercial laboratories in the United States, which have been most patriotic in offering to investigate special ordnance problems. Some of this work has been in connection with orders received from the War Department, but much of the activity has been based upon the patriotic desire of industry to assist in national defense. In many cases, programs have been executed without cost to the Government. The number of companies which have contributed to the development of weapons for the War Department is so great that it would be impracticable to review these activities in this article. However, a few companies from the list will be mentioned in order to give a conception of the extensive field covered by these activities. It should be understood that there are many companies not mentioned which today are conducting important research programs for the Department.

The Sperry Gyroscope Company devotes a large part of its research facilities to ordnance work. This company conducts independent research pertaining to antiaircraft directors and all types of fire-control instruments, supplementing the work done by the Frankford Arsenal laboratories. The Bausch & Lomb Optical Company of Rochester, N. Y., and the Keuffel & Esser Company of Hoboken, N. J., have been working for many years on stereoscopic height and range finders which form an important part of the fire-control systems for various types of artillery.

The General Motors Corporation is developing a special 2-cycle diesel engine for Army tanks. The engine is being built as a 4- to 12-cylinder unit with the idea of covering the range of power plants required for all types of tanks.

The Timken-Detroit Axle Company has done effective work in the field of front and rear drives for combat vehicles and in the design of bogies for high-speed gun carriages. A recent successful accomplishment has been the bogie and limber system for the new long-range 155-mm. gun carriage, lately standardized for the Army. Many other companies in the automotive field have likewise contributed to the improvement of combat vehicles. Included in this list are James Cunningham Sons & Company, American La-France and Foamite Corporation, Corbit Company, Marmon-Herrington Company, Caterpillar Tractor Company, Allis-Chalmers Manufacturing Company, International Harvester Corporation, and many others.

The Standard Oil Company at Bayway, N. J., having extensive research laboratories, patriotically has offered its services to the Department. A recent successful development has been a new recoil oil for aircraft cannon permitting guns to be operated at temperatures as low as –60 degrees Fahrenheit.

The large laboratories of the Du Pont Company are constantly at work on problems pertaining to the development of propellants and explosives for the Department. This company has been active in the successful production of flashless nonhygroscopic powder now standard for Army use. The Hercules Powder Company has aided the Department for many years in the development of propellent powders and of the double-base nitroglycerin type necessary for the ignition cartridge and propellent increments of small mortars. It also has developed a propellent powder for small cannon of high potential. Other companies coöperating with the Ordnance Department in the development of various ammunition components are the Campbell Wyant & Cannon Company, Murray Manufacturing Company, Steel Improvement & Forge Company, Standard Products, Carpenter Steel Company, General Railway Signal Corporation, Westinghouse Electric & Manufacturing Company, American Brass Company, International Flare-Signal Company, Waltham Horological Company, A. O. Smith Company, American Car & Foundry Company, Consolidated Steel Corporation, and others. The National Tube Company has made valuable contributions through its work on bombs and seamless-tube projectiles.

The Winchester Repeating Arms Company is at present engaged on research concerning a new type of antitank gun and its armor-piercing ammunition. The company was supplied by the Department with basic data concerning caliber, projectile, weight, and muzzle velocity considered necessary, and the company is working on a weapon based upon these characteristics. The Colt's Patent Fire Arms Company

is almost continuously employed in the improvement of various types of machine guns and automatic cannon. An important accomplishment has been the 37-mm. automatic antiaircraft gun.

The Aluminum Company of America has assisted the Ordnance Department for many years in the solution of its problems involving the use of light aluminum alloys for various types of ordnance equipment, including artillery and ammunition components. The laboratories of this company have been able to meet many of the rigid requirements of the Ordnance Department for alloys of great strength.

In matters pertaining to the study and development of gun forgings, hoops, and breech rings, such firms as the Midvale Company, Bethlehem Steel Company, Republic Steel Corporation, National Forge & Ordnance Company, Crucible Steel Company, Carnegie-Illinois Steel Company, Edgewater Steel Company, and others have coöperated with the Department and have rendered valuable assistance.

In the development of armor plate, several manufacturing companies have coöperated extensively. The metallurgical laboratory at Watertown Arsenal has been able to assist companies desiring to enter this line of endeavor. The quality of armor plate made in the United States has been steadily improving and, where comparisons have been possible, it has been found that this plate is superior to that manufactured abroad. Some of the American concerns which have coöperated are Henry Disston & Sons, Inc., Diebold Safe & Lock Company, Carnegie-Illinois Steel Company, Van Dorn Iron Works, Lebanon Steel Foundry, the Kellogg Company, General Electric Company, Simonds Saw & Steel Company, American Car & Foundry Company, International Nickel Company.

A senior officer of the Department with broad ordnance experience is assigned specifically to the task of maintaining contact with and obtaining from technical societies and commercial and Government laboratories, research data and information of value in the solution of ordnance problems. This officer holds membership on appropriate committees of practically all engineering and scientific research bodies. He also maintains direct contact with educational institutions and industrial research organizations. In addition to his activities, many of the officers and engineers of the Department are members of appropriate technical societies and actively participate to the end that the organization may be kept fully abreast of all fields of engineering and science.

The National Research Council, an agency of the National Academy of Sciences, was created in 1916 at the request of President Wilson to assist the Government in organizing the scientific resources of the country. By executive order of May 11, 1918, the National Academy of Sciences was requested to continue the National Research Council to serve as a means of bringing American and foreign investigators into active coöperation with the scientific and technical services of the War and Navy Departments and with those of the civilian branches of the Navy.

While the facilities of the Ordnance Department are adequate in most cases, it is necessary to call upon the National Research Council to aid the Department in the solution of special basic research problems. When a problem in basic research is presented to the council, a suitable committee is appointed to investigate it. The council will render advice and recommendations concerning such basic research problems or, if desired, will conduct the necessary research work.

The Ordnance Department of the Army throughout its history has fully realized the great importance of research in the evolution of fighting equipment. It has had a continuous research policy over a long period of years, as shown by the record of the laboratories of the various arsenals. The early investigative work conducted by Ordnance arsenals unquestionably had its influence in the present extensive use of research in industry.

Each year the weapons of war become more complicated in their nature and more difficult to produce. Modern armies are more fully mechanized each year, and today wars cannot be waged successfully without the use of these new machines.

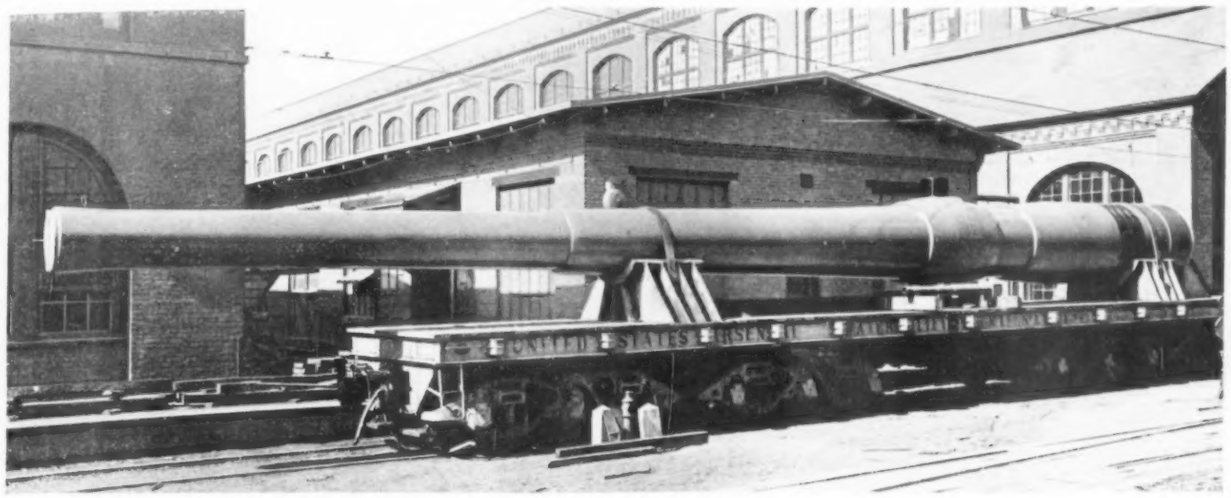
The progress which the Department can make in any one year in the development of munitions depends very largely upon the appropriations which are available for this purpose. While a large research appropriation in any one year accelerates progress and development, the Department feels that it is much more desirable to have an adequate appropriation for research available year after year. It takes a long time to organize and train qualified research personnel with special knowledge of ordnance. Most of these problems are of such a nature that they cannot be solved overnight but must be kept continuously under investigation. The fighting weapons which will be used in the next war will be largely those for which the research-and-development problems have been solved previously. While research would be greatly intensified in case of a war emergency, effective weapons which are developed after the emergency starts will be the exception rather than the rule.

The Department is very appreciative of the splendid cooperative spirit shown throughout industry and the willingness of scientists and engineers in civil life to assist the Department in every possible way in the solution of its difficult technical problems. Through the use of the qualified research personnel in Ordnance establishments, assisted by the great research staffs and laboratories of this country which are unsurpassed by those of foreign states, our armies in any future war will be equipped with weapons at least the equal of, and in most cases superior to, those to be found in the hands of any possible enemy.

EDITOR'S NOTE.—This article is of such timely significance that, together with the illustrations on the following eight pages, it will be reprinted in pamphlet form for complimentary distribution. It frequently is said these days by commentators who should know better that our Army is hidebound, especially in the adaptation of new ideas; that its research and development are not up to date. This is particularly a charge of inventors whose elaborate brain children would revolutionize combat if only their contrivances were given a chance. Colonel Barnes, in the above article, not only disproves this viewpoint but offers conclusive evidence of the breadth of attack which the Ordnance Department has maintained for many years upon the technical and scientific problems of weapon research. Far from shunning innovations the Army, almost from its very beginning, has devoted much time and effort to seeking practicable improvements in its weapons and materials. Readers will perform a useful service by bringing this pamphlet to the attention of people who are interested in the facts. Copies may be obtained without cost upon application to the Editorial Offices, Army Ordnance Association, 806 Mills Building, Pennsylvania Avenue at 17th Street, Washington, D. C

Science in Armament

THE Ordnance Department of the Army has the responsibility for the design, development, procurement, storage, issue, and maintenance of the weapons used by the Army—a total of some 1,200 separate items, together with about 250,000 components in the categories of cannon of all sizes and their mounts, rifles, pistols, machine guns, fire-control instruments, tanks, combat cars, scout cars, bombs, pyrotechnics, and all types of small-arms and artillery ammunition and aircraft armament. "Ordnance" includes all these.



It is an Ordnance Department policy of long standing to maintain close contact with private research-and-development institutions and organizations for the full utilization of engineering progress. This policy today is bearing fruitful results and is at once a guarantee of sound advancement both in the use of engineering techniques and their constant application to the design, production, and maintenance of our military armament.

The Department also has found it desirable, in view of the diversified character of the work, to have a number of laboratories specialize along particular lines rather than to have one large research laboratory work on all problems. The Department therefore operates laboratories in each of its six manufacturing arsenals—each arsenal being engaged in research and development of the material assigned to it. These arsenals are located at Springfield, Mass.; Watertown, Mass.; Rock Island, Ill.; Watervliet, N. Y.; Philadelphia, Pa. (Frankford), and Dover, N. J. (Picatinny). At the Aberdeen Proving Ground, Md., facilities are maintained for testing completed experimental models and also for ballistic research.

The basic research conducted at these Ordnance laboratories is devoted to those fields which do not overlap civilian scientific and commercial activities. Most of the investigations of the arsenal laboratories quite naturally are aimed at applying scientific principles directly to the solution of specific problems of Ordnance engineering. However, many of the advances made in the search for better armament have resulted in many permanent and comprehensive benefits to commercial manufacture and civil convenience.

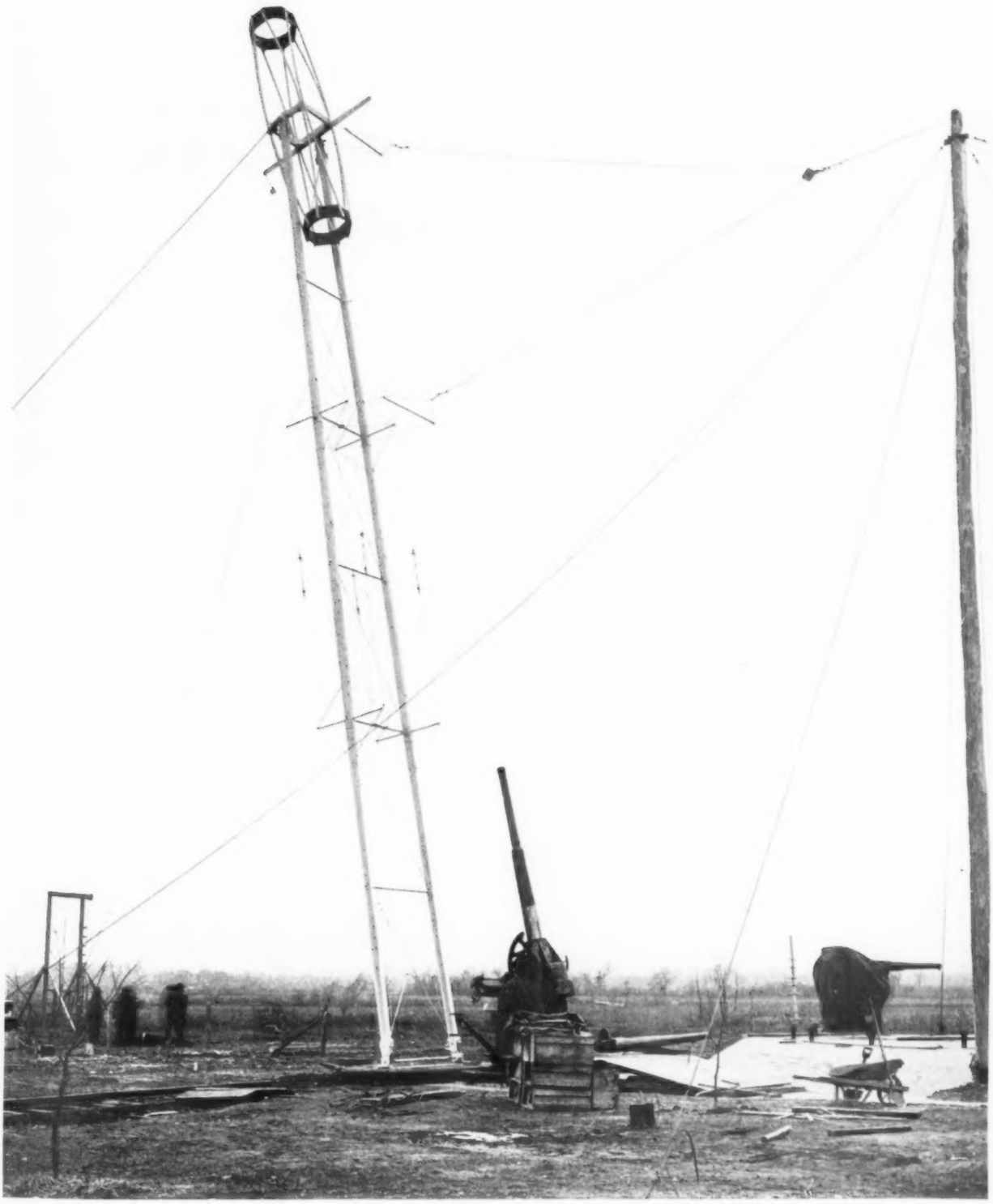
Ordnance research is primarily a peace-time function. Scientific investigation and experimentation require unlimited time and painstaking attention to the smallest details. In emergency, time is of the essence, and production rather than experimentation becomes the watchword. Existing types of armament must be "frozen" and tools, jigs, and dies provided in great numbers to produce these types in quantity. No changes, however minor, that will necessitate retooling and slowing down production can be tolerated under stress of a major national emergency.

The Ordnance Department always has realized this and has been striving throughout the years to provide the nation with the best possible means of defense. Unheralded and unsung, laboring often under the anonymity demanded by secrecy, the scientists and engineers of the Ordnance Department have striven ceaselessly to give to the armies of the United States the best in arms, ammunition, and implements of war—so necessary for our national security.

Research in Exterior Ballistics

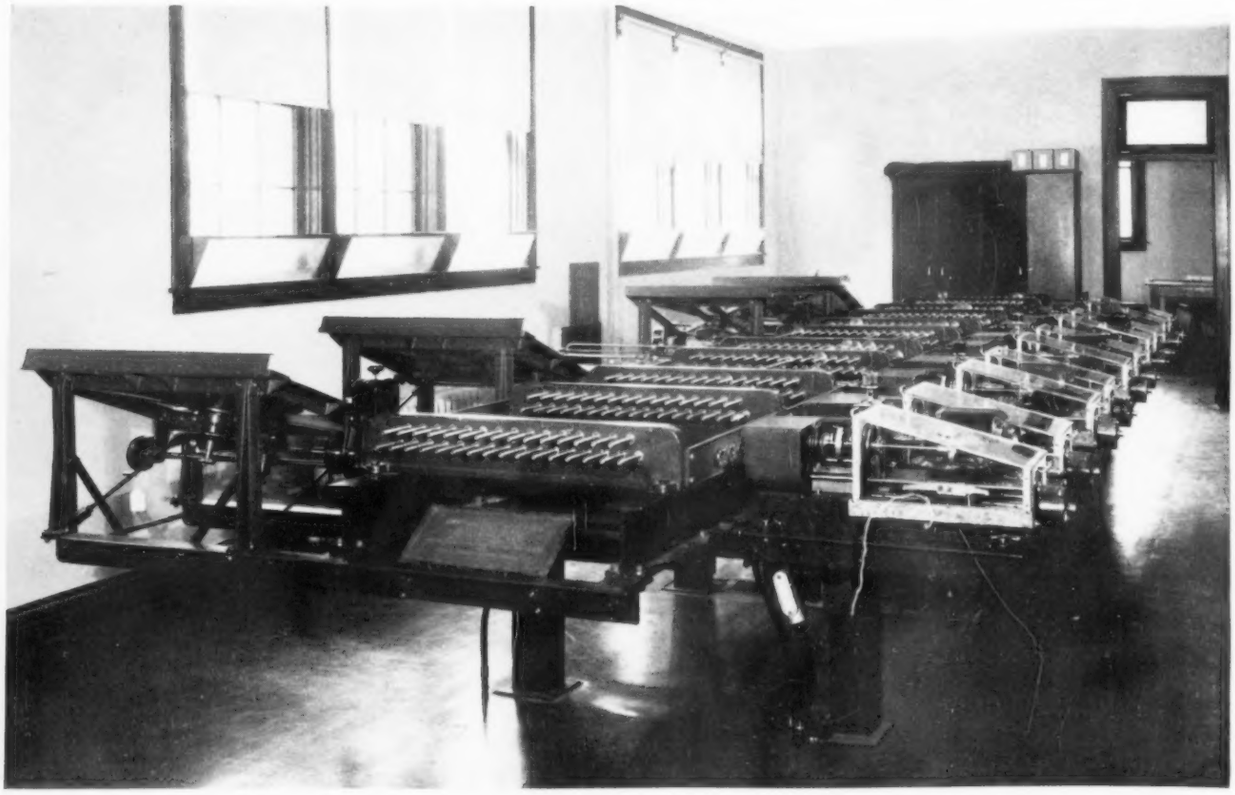
Above is shown the firing range for projectile aërodynamics at the Aberdeen Proving Ground. The projectile is fired through the series of cards and the shapes of the resulting holes disclose its characteristics of flight. Other exterior-ballistic experiments conducted here determine such data as the effect of air resistance on the flight of projectiles and the influence of various forms of shell and of rifling in guns upon the stability of projectiles.

Measuring Projectile Velocity

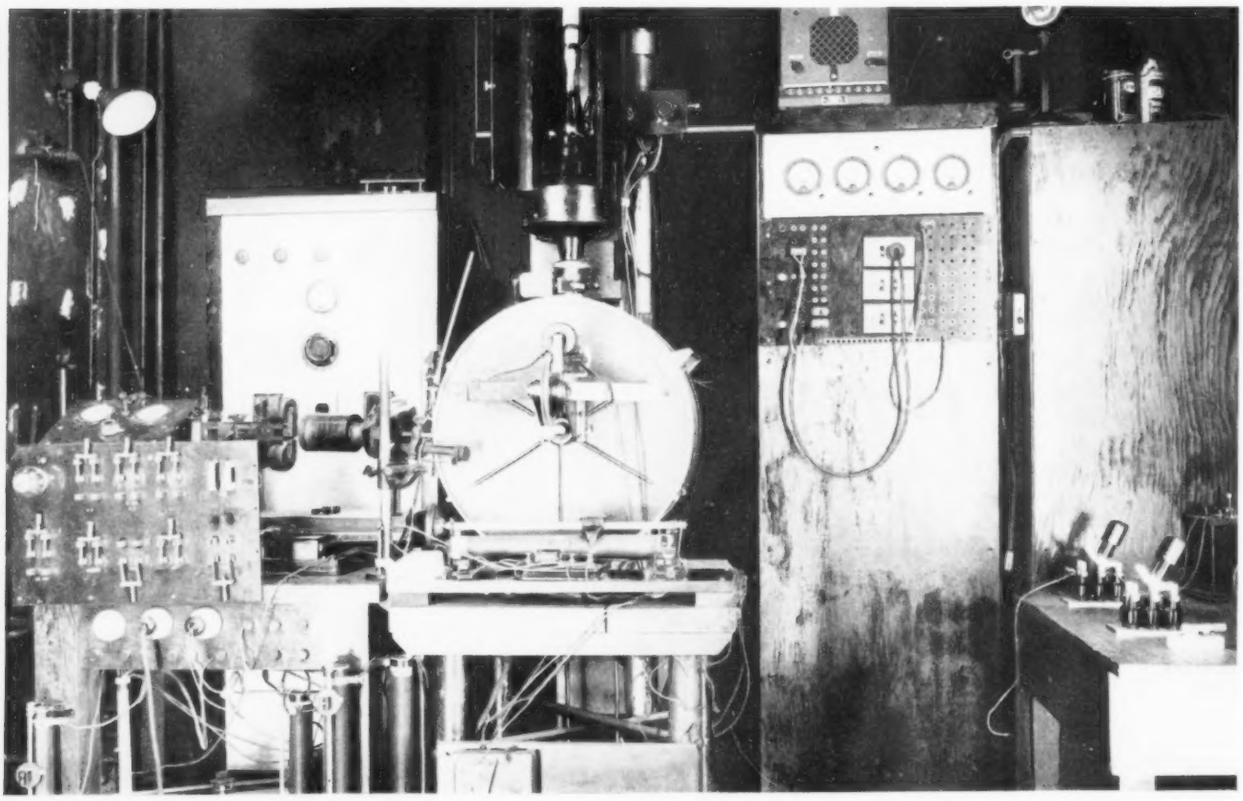


The apparatus shown above at the Aberdeen Proving Ground is a solenoid chronograph for measuring the velocity of projectiles. The time taken by the projectile to pass from the magnetic field at the near end of the solenoid through the magnetic field at the farther end is used to determine its muzzle velocity. The Aberdeen Proving Ground, occupying 24,000 acres, includes a gun and ammunition testing laboratory, an automotive testing laboratory, and a ballistic laboratory.

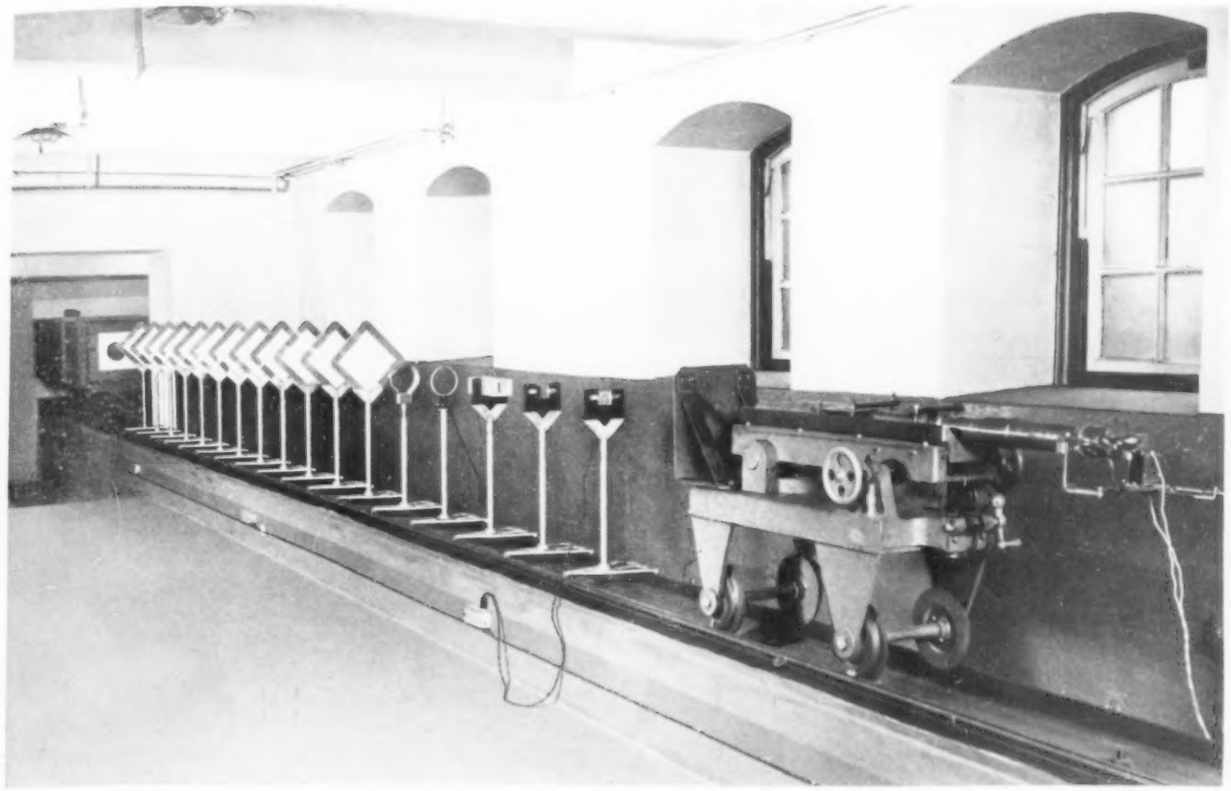
Modern Machines Aid Ordnance Research



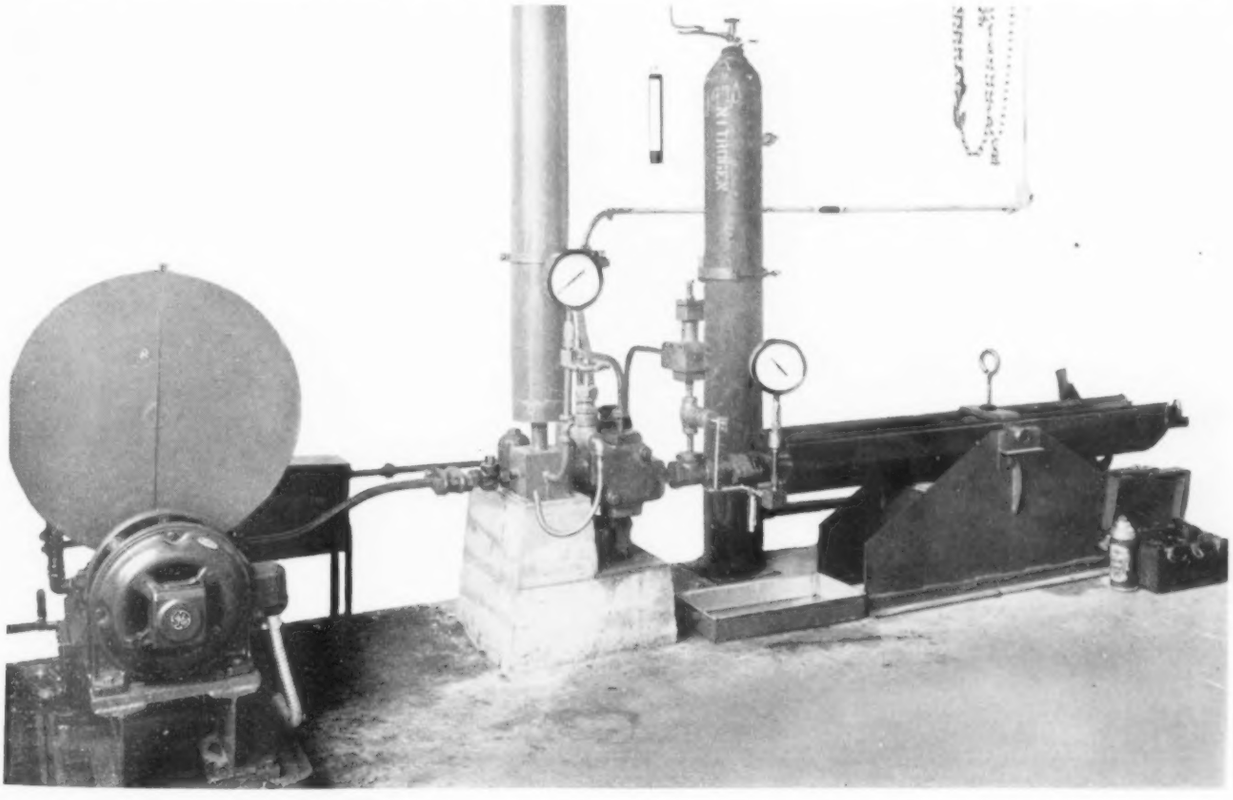
Data about the forces acting upon projectiles are used in compiling firing tables. One of the four Bush differential analyzers in the country, shown above installed at the Aberdeen Proving Ground, is used in calculating the trajectories upon which such tables are based. The recording apparatus of a piezo-electric gage for measuring cannon pressures is shown below.



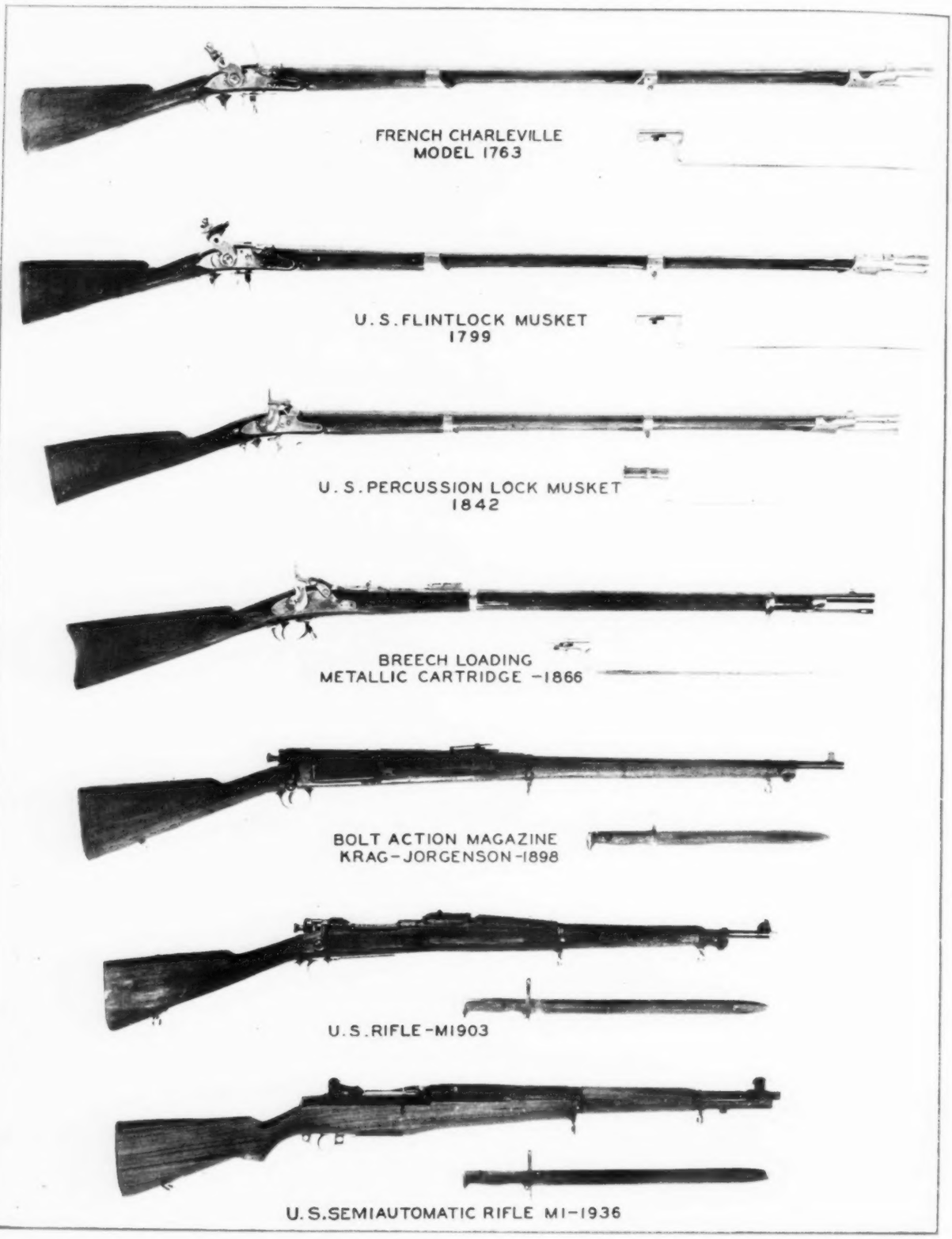
Testing Small Arms and Artillery Components



Typical equipment used on the ballistic range at Frankford Arsenal is shown above. This arsenal conducts research principally in problems connected with small-arms ammunition, artillery shells, and fire-control instruments. An hydraulic gymnastiqueur for testing 75-mm. gun recoil mechanisms is shown below installed at the Rock Island Arsenal.

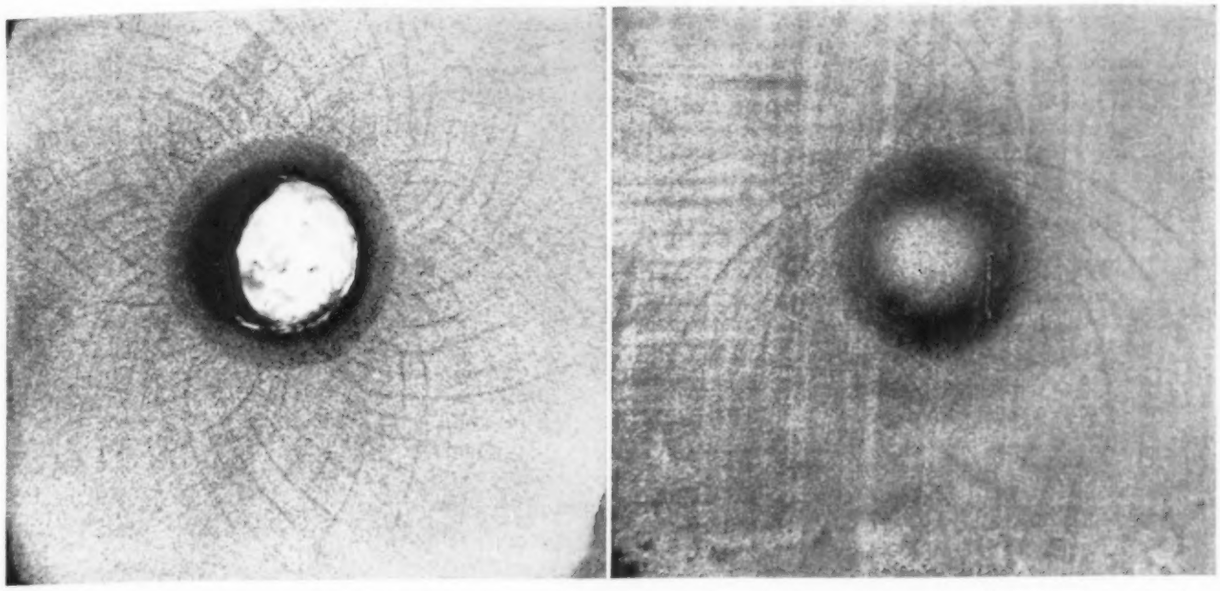


Epochal Types of Military Rifles

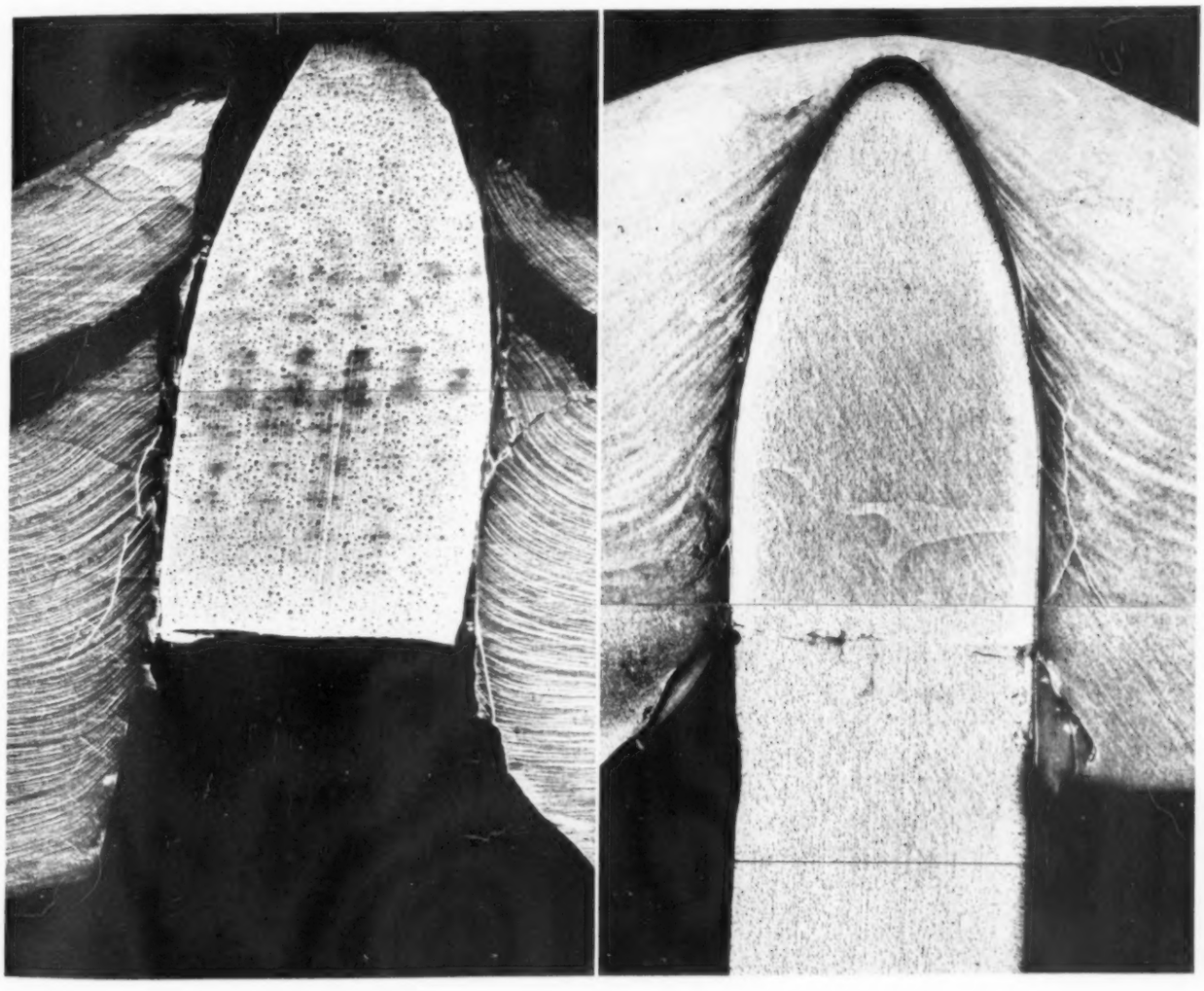


Since 1795, Springfield Armory has been manufacturing small arms for the armies of the United States, including all but the first of the epochal types of shoulder weapons shown above. Its research activities in the production of nearly forty types of military rifles have culminated in the new semiautomatic rifle, caliber .30, M1, after twenty years' development. Springfield Armory has contributed greatly to the progress of interchangeable manufacture so essential to mass production.

Experiments with Armor versus Bullet



In the illustrations above, Lüders' lines are shown in a low-carbon steel plate tested by a caliber .30 armor-piercing bullet. The face of the plate is at the left, the rear at the right. At the left, below, is shown the effect of an armor-piercing bullet on poor quality armor plate, and at the right, an armor-piercing bullet stopped by armor plate.



Ordnance Metallurgical Research

A Charpy impact machine for hardness testing is shown above installed at the Watertown Arsenal. This arsenal is engaged in the manufacture of gun forgings and centrifugal castings, railway, seacoast, and antiaircraft artillery. The laboratory of the Ordnance Department located here is the center for general and ferrous metallurgical research activities which cover such fields as plasticity of metals, improvement of armor plate and armor-piercing ammunition, etc.

Streamlined Preparedness

Closing the Gaps in the Timetable of Industrial Mobilization

By Col. James L. Walsh*

SHORTLY after the World War, Congress appropriated billions of dollars for national defense. But Congress did not—because it could not—appropriate a single second of time. Today, in a sense, the activities of the Army Industrial College are part of a concerted, determined effort to "appropriate" time by studying problems that can be solved before the outbreak of war; by doing ahead of time everything that can and should be done ahead of time.

Unquestionably, we are much better prepared today to meet a national emergency, provided it would come upon us *exactly like the last war* in every respect. Everything that has been done has been a move in the right direction—but have we moved far enough? We have taken effective measures to conserve time—that most precious of all commodities in emergency; the grave question is whether we have saved enough time to offset the quickened tempo of sudden, unannounced moves on the international chessboard—kaleidoscopic realignments in foreign affairs, hostilities without the formality of a declaration of war or even the issuance of an ultimatum.

Have we figured on the lightning speed with which aggressor nations are capable of mobilizing and manipulating their entire resources, and the nerve-shattering new velocity that *Blitzkrieg* has demonstrated in maneuver and attack? Undoubtedly we have made great progress toward the goal line; but, as we have moved forward, have the goal posts been moved back as fast—or even faster?

Even in the prosecution of what eventually was a successful war, the dollar value of time passed beyond any ordinary human comprehension. President Calvin Coolidge, in an address at the observance of the tenth anniversary of the Armistice in Washington on November 11, 1928, said: "Up to the present time our own net war costs, after allowing for our foreign-debt expectations, are about $36,500,000,000. With what has been paid out and what is already apparent, it is probable that our final cost will run well toward $100,000,000,000, or half the entire wealth of the country when we entered the conflict."

Even in these days of astronomical appropriations, one hundred billion dollars is a huge sum. From April 6, 1917, until December 31, 1919, is 1,000 days. Therefore, after allowing something over a year for demobilization and retrenchment, the final cost of the World War amounted to $100,000,000 per day—day in and day out for a period of 2 years and 9 months.

So, when the Army Industrial College seeks to do ahead of time the many things that can and should be done ahead of time, it really is seeking to help save one hundred million dollars a day for the taxpayers in the event of another national emergency. For every 10 days gained in putting our industrial machine into high gear for purposes of national defense, a saving of $1,000,000,000 is indicated. If it is a bit difficult to grasp the significance of that fact, let us remember that the Panama Canal took ten years to build and cost approximately $500,000,000. Accordingly, the Army Industrial College and other agencies seeking to speed up industrial mobilization save the cost of another Panama Canal for every five days by which a future emergency is shortened.

That calculation, of course, is based upon facts and figures of the last war. If anything, the cost of military operations today is very much greater than it was in 1917. Today's increase in mechanization and motorization as compared with that of the World War means two things: greatly increased first cost, and a greatly increased tempo of activity which, in itself, begets increased costs of operation and maintenance.

Now it is true that what savings can be made are not due entirely to the activities of the Army Industrial College. All the things that the industrial-preparedness movement has urged for the past twenty years have helped cut the cost of participation in a future war.

CURRENT events indicate the imperative need of taking stock of our situation today. While we certainly can list many accomplishments in the field of industrial preparedness which contribute substantially to the national defense, nevertheless, we may well discover new conditions which tend to make the job ahead even more difficult in some respects than it was twenty-three years ago.

Brig. Gen. Benedict Crowell, the Assistant Secretary of War and Director of Munitions during the World War, in his report, "America's Munitions," made the following statement:

"When the war touched us, our strategical equipment included plans ready-drawn for the mobilization of men. There were on file at the Army War College detailed plans for defending our harbors, our coasts, and our borders. There were also certain plans for the training of new troops. It is worthy of note, however, that this equipment included no plans for the equally important and equally necessary mobilization of industry and the production of munitions, which proved to be the *most difficult phase* of the actual preparation for war."

That was the situation as it existed in April 1917. Conditions are different today. Numerous steps have been taken, as outlined below, to make the United States industrially prepared for national defense. First of all, the National Defense Act, as amended on June 4, 1920, now specifically places responsibility for having a plan for industrial mobilization as follows:

"Sec. 5a. Hereafter, in addition to such duties as may be assigned him by the Secretary of War, the Assistant Secretary of War, under the direction of the Secretary of War, shall be charged with supervision of the procurement of all military supplies and other business of the War Department pertaining thereto and the assurance of adequate provision for the mobilization of matériel and industrial organizations essential to war-time needs . . ."

*Founder and first editor of ARMY ORDNANCE (1920-1922). Director, Army Ordnance Association. Formerly chief, New York Ordnance District. This is an address delivered recently before the Army Industrial College, Washington, D. C.

Secondly, the Industrial Mobilization Plan is now in existence. This broad directive has been completed and has been approved jointly by the Secretary of War and the Secretary of the Navy. Under this general plan, the industrial activities of the Army and the Navy are coördinated, and the aggregate effort they require is adjusted to the commercial life of the nation. Duplication of effort and the resultant waste of time and money are avoided in so far as possible. The plan is brought up to date periodically. This is most important, for conditions change, and we must be alert to adapt our plans to new situations.

Thirdly, the determination of estimates and requirements is, of course, the first and essential step toward securing an effective and economical mobilization of industry. What is required, when it is required, and where it is to be delivered have been computed with great accuracy and completeness, certainly to a degree which should minimize delay and lost motion. But this work must be kept up to the minute in the light of recent developments.

Detailed branch procurement plans also have been worked out by the various staff departments, and the necessary administrative mechanism for coördinating and controlling them has been set up in the Office of the Assistant Secretary of War. This promotes teamwork and helps produce a balanced program.

TODAY we have the procurement-district system which puts into effect the very important principle of decentralization of authority. This avoids an administrative "bottle neck" in Washington. The procurement-district system, in addition to being available for use in time of war, is also functioning in time of peace. Accordingly, officers of the Regular Army and Reserve Corps detailed to this activity have a chance to work out on a small scale—but on an actual day-to-day basis —the sort of administrative problems with which they would be confronted on a very large scale in the event of war. Smoothly functioning administrative machinery cannot, of itself, win a war; but poor administration certainly can prolong one—and even place the outcome in jeopardy.

Production studies, originally undertaken as a practical substitute for educational orders, have yielded in concentrated form the necessary information upon which commercial plants can proceed to inaugurate maximum production of a given article of equipment within a minimum time.

The statutory authorization for placing educational orders gives American industry its chance to prepare for its wartime job. It took twenty years of ceaseless endeavor to bring about this condition—probably the greatest single contribution to prompt and effective mobilization of industry for the national defense. It should be expanded to the fullest extent to make up for twenty years of neglect.

Appropriations for the purchase and storage of strategic and critical materials now make it possible to accumulate reserve stocks of those commodities of which the United States produces within its borders either none at all or quantities insufficient to maintain the industrial war effort without interruption and delay.

The Army Industrial College brings together a selected group of officers and gives them the facilities and the time to learn to think accurately and soundly in meeting such special situations as may arise when the mobilization of industry becomes necessary.

The Army Ordnance Association and similar organizations have served to keep alive knowledge necessary to the prompt manufacture and supply of the various classes of military articles assigned to their corresponding branches in the Regular Army. The American Society of Mechanical Engineers, the Society of Automotive Engineers and other engineering societies devoted primarily to peace-time activities also have taken a commendable interest in industrial mobilization, so that there is now a vast fund of knowledge upon which the nation can draw—a fund of knowledge which was not available twenty-three years ago.

Back in 1917, none of these agencies or facilities were in existence, and most of them were not even dreamed of. But the World War taught America a few lessons. Perhaps the outstanding lesson was, to quote General Crowell again, that "the war taught us that America can organize, train, and transport troops of a superior sort at a rate which leaves far behind any program for the manufacture of munitions. It upset the previous opinion that adequate preparedness is largely a question of trained man power."

The emphasis here is obviously upon *time*. The United States could produce munitions—the great lesson was that *we could not produce them in time*. We could not produce arms and military equipment quickly enough to keep pace with the organization and training of an expanding army. If we had lacked the shelter of the Allied Armies during the World War, the result would have been disastrous—and may be so in the future unless the munition-power program is started well ahead of the man-power program.

THE United States knows how to feed men; to clothe them; to house them; to provide them with the best of medical, surgical, and dental care; to pay them generously; to transport them quickly by land, water, or air; to provide them with instantaneous communication by telegraph, telephone, or radio, because all these war-time activities have parallel peace-time counterparts to keep alive and extend the knowledge necessary to effect them. But the nation does not know, from its peace-time activities, how to convert men into soldiers by putting into their hands the tools of their trade—collectively called ordnance.

Without shoulder rifles, pistols, machine guns, artillery, and ammunition for these; without tanks and armored cars; without ammunition trucks and mobile ordnance repair shops, the bravest men in the world are but cannon fodder. Without bombs and machine guns the best airplanes in the world are useless as military weapons. Solution of the ordnance problem is the crux of the entire program of national defense.

The curriculum of the Army Industrial College is eminently well adapted to serve its purpose. The officers who have an opportunity to take this course are to be envied. It is hoped that, when they return to other duties, they will devote some attention to educating the Regular Army to the fact that "all other preparations, both in organization, personnel, and matériel can take place faster than the manufacture of arms and ammunition, which therefore sets the pace at which the country can make ready to wage war"—a well-nigh axiomatic principle enunciated by the great Gen. William Crozier in his book, "Ordnance and the World War."

It will be a long step in the right direction when War Department policy requires that an officer will have to be a graduate of the Army Industrial College as well as the

Army War College before he will be considered eligible for high command—or indeed for appointment to key positions on the War Department General Staff. Then will come naturally the new conception of developing a balanced program of what industry in this country can provide in the way of arms and equipment, and upon this the man-power program will be based.

It is trite but true that preparedness measures may unconsciously be predicated upon conditions which obtained during the last war instead of being directed at the next war. Having listed some of the accomplishments of the past twenty years in the field of industrial preparedness, we must endeavor to appraise them in the light of changed conditions. To begin with, on April 6, 1917, our national debt was approximately $1,500,000,000; now it is more than thirty times greater. Twenty-three years ago there were few, if any, statutory restrictions on raising "risk money" to finance industrial enterprises connected with the war effort. There were no Federal regulations as to minimum wages or maximum hours to affect the output of munitions. Neither were there complex statutes regarding labor relations or the protection of munitions plants from espionage or sabotage. Whether these factors will accelerate or impede production remains to be seen.

In any case, the primary objective of the program for industrial preparedness is to organize the industrial resources of the nation in readiness to produce munitions of proper quality, in proper quantity, at the proper time as determined by proper authority—all to the end that a threatened emergency may be averted, or an existing emergency be terminated within a minimum time. The problem of securing complete social, economic, and political justice for all concerned can be considered safely only in so far as it helps in the attainment of the primary objective. The greatest help to any program of betterment is to avert war if possible or to win the war quickly if war is again "thrust upon the United States." Conversely, the greatest misfortune that can befall our present or future way of life is involvement in a long-drawn-out, unsuccessful war. National security is a prerequisite to social security.

AMONG the changed conditions under which industrial preparedness must function in 1940 as compared with 1917 is the ever-increasing emphasis upon speed. Just as our combat divisions have had to be streamlined in order to meet the demand for speed in the theater of operations, so our plans for industrial preparedness must be streamlined to meet the new requirements. Speed in reconnaissance, estimate of the situation, issuance of combat orders, and execution of mission must be matched with corresponding speed in completing surveys of industrial resources, estimates of requirements, negotiation of contracts, and in getting into production.

The increased celerity of action of the new triangular division has necessitated decentralization of authority once combat is joined. Greater reliance has to be placed upon the initiative and resourcefulness of unit commanders. So, too, decentralization of authority must be effected in the industrial phase to a degree even greater than that provided by the present district procurement system. Once the objective is determined, greater reliance must be placed upon the initiative and resourcefulness of industrialists who alone are competent to achieve production.

The potential contribution of the various procurement districts toward meeting a possible national emergency lies wholly in the commercial plants which have been assigned to produce munitions in the event of war. District headquarters, the industrial services of the various staff departments in Washington, and the Office of the Assistant Secretary of War exist principally to assist this potential strength to be exerted promptly, effectively, and efficiently.

Today, one fact stands out in crystal clarity. Time is more than ever the determining factor in war—in the industrial program as well as in the combat zone. Furthermore, every increase in tempo of maneuver requires a corresponding increase in rapidity of mobilization of matériel as well as personnel. In the World War, satisfactory movement of a division in maneuver was ten miles a day. Now the division can average 90 miles a day, and has traveled as much as 200 miles a day. The gasoline engine on land and in the air has revolutionized logistics—probably far beyond our ability to comprehend, unless we constantly take positive steps to estimate its implications. In planning industrial mobilization, we must constantly remind ourselves not to prepare for the next war in terms of the last one.

Only recently, Col. Frank P. Lahm, Air Officer, Second Corps Area, predicted the use of airplanes to supply armies, stating that the United States Air Corps' present fleet of eighty transport airplanes had been developed in the same way that motor transport trains have been developed to serve military ground units. Colonel Lahm said:

"Aviation tactical units must be self-sufficient and independent of the slower rail and motor transportation systems. The average speed of railroad freight transport is 16.7 miles an hour—air transport, 140 miles an hour. . . . The time has passed when armies in the field are compelled to rely solely on ground and water lines of communication. Today we see campaigns carried out in theaters of operations that would be inaccessible except for air transportation. . . . It requires little vision to see the next step in Army transportation from the motor truck to the airplane."

All indications point to even more emphasis on speed in the future as compared with the present. Speed is a factor in momentum and in kinetic energy—perhaps the controlling factor. However, there are other factors and we cannot neglect them. Among these is weight—the natural enemy of speed. And streamlining is "that new principle which eliminates dead weight and anything else that interferes with speed or efficiency."

That definition applies with equal force in a figurative sense, as well as in a physical sense. A program to eliminate administrative dead weight and anything else that interferes with speed or efficiency in the mobilization of industry isn't a bad definition of "streamlined" preparedness.

Statutory restrictions, legalistic interpretations, bureaucratic meddling and muddling, and slavish adherence to form, make other "fifth-column" activities largely unnecessary. Modern war now requires far less time to annihilate an army and enslave a whole people than the Revised Statutes require shall elapse in advertising for competitive bids.

IN a purely physical sense, too, elimination of dead weight increases speed. Lacquer for the metal surfaces of aircraft has been reduced from 40 pounds per coating to 15, and speed has thereby been increased 5 miles an hour. Twenty years' research has reduced the weight of airplane engines from 2½ to 1¼ pounds per horsepower. Elimination of

needless dead weight has helped to increase speed, payload, radius of action—or to bring about some advantageous combination of speed, range, and attacking power.

Aviation clearly points the way toward increased speed. Since we already have increased the tempo from that of the foot soldier and escort wagon to that of the tank and motor truck and apparently are seeking the vastly higher speed of the airplane, streamlined preparedness dictates the need of a thorough survey of all military equipment with a view to eliminating dead weight and anything else that interferes with speed or efficiency.

New plastics and new alloys of steel, aluminum, or magnesium are lighter and less bulky for the same strength. In the commercial world they are rapidly displacing the old heavy and bulky materials. But better design, even utilizing the old materials, also can help increase speed by pruning parasite pounds.

The *New York Times* of March 14, 1940, reported the issuance of a ruling by the British Timber Control that hereafter all broom handles must be square instead of round; that in the future 10,000,000 containers for food tins must be in the form of crates instead of boxes; that the weight of wood in 1,000,000 cordite (powder) boxes had been cut 25 per cent; and that the weight of wood in 1,000,000 army benches had been cut 60 per cent by substituting slatted tops for solid tops, and so on. Editorial comment in a New York morning newspaper noted that these announcements "excited amusement in some quarters." If so, it was a $10,000,000 joke, because that is the amount the British Timber Control estimated would be saved during the first year—not to mention a reduced consumption of imported softwoods of 250,000 tons a year for which 350,000 to 400,000 tons dead weight of shipping otherwise would be needed.

That these figures are not out of line with possibilities is apparent from a re-reading of General Crowell's report rendered at the close of the World War:

"Now, while it was important that Army supplies reached the other side in good condition, it was soon seen that of even greater importance would be the economy that might be effected in shipping space by the scientific packing of goods. This obscure and little-known packing-service branch was really one of the most important agencies in the whole war organization since the results which it accomplished in the saving of ship space were nothing short of astonishing. These economies came at a time when the German submarines were still highly destructive to American and Allied shipping, and the shortage of ocean tonnage was one of the most disturbing factors in the whole war situation. The American packing service, in saving thousands of tons of shipping space, in reality offset the operations of the U-boats over a considerable period of time.

"These space economies resulted usually from specifications drawn by the packing experts reducing the sizes of packing cases that were too large for the goods contained and also by packing articles more compactly. . . . The experts studied boxing to determine the best thickness of wood required by various commodities and the proper method of strapping or otherwise fastening the boxes. As a result, there was a great improvement in the condition of goods arriving in France" ("America's Munitions," pp. 489-491).

General Crowell gave detailed figures showing a saving of $55,000,000 in a single year in the shipment of clothing alone, not to mention "a large saving in raw materials which count for more than money to a nation engaged in a desperate war."

IF such savings are attainable in connection with what we may call horizontal transportation, that is, transportation generally parallel to the earth's surface, either by land or water, how much greater will be the effect of saving in weight when we enter the field of vertical transportation—transportation by air. And since air transportation of military supplies is predicted for the comparatively near future, more and more attention will have to be concentrated on the elimination of unnecessary dead weight.

In this connection it may be of interest to recall that a few years ago a manufacturer, who used large quantities of a certain material, felt that his shipping containers were much too strong and therefore much too heavy, and hence were costing him too much in freight. The primary attack on the problem was successful in saving freight charges of $54,000 per year. These boxes, containing from 500 to 800 pounds, were lifted from freight cars by a traveling crane and stacked in tiers to a height of about 30 feet. Savings due to the lighter packages were almost as much in crane-handling costs for vertical transportation as the savings in railroad freight charges for horizontal transportation.

Only a few years ago "lightweight" was a term of derision; now it is fast becoming a selling point. Current news items and advertisements evidence the growing recognition that needless weight is needless waste, and that accurately adequate strength is the road to increased sales and profits.

In the commercial world, first cost of any article is a prime consideration, and if the product has to be shipped from the place of manufacture to the place of use, the freight charges on it are also of great importance. While the Army and Navy are interested in first cost and freight charges on articles procured for the combat forces, they are even more interested in delivering the greatest number of units to the place where they are to be used with the least drain upon available transportation.

In war, the kinetic energy of attack increases directly with weight but increases as the square of velocity. Velocity, in turn, increases directly with distance covered in a given time, but inversely with time required to traverse a given distance. Hence, if weight is doubled, striking energy is doubled. But if time is halved, striking energy is quadrupled, and if time is cut down to one-third, striking energy is increased ninefold—which perhaps explains the startling effectiveness of today's wars. Moreover, to maintain the same striking energy, halving the weight means quadrupling the velocity (or quartering the time required to traverse a given distance).

In maneuvers preliminary to attack and subsequent physical impact, military considerations will determine the optimum relationship between weight and velocity. However, until the theater of operations is reached, any weight not required and utilized in impact is obviously waste weight for which a high toll in remaining velocity (and therefore in striking energy) has been exacted to no useful military purpose.

Streamlined preparedness—by eliminating dead weight and anything else that interferes with speed and efficiency—may help close the time gap which modern war appears to have opened in the present timetable of industrial preparedness. "The law of gravity never sleeps"—and cannot be repealed.

Rearmament Progress

Statistics of the Current Program

AS AN indication of the great progress already made in the production of military armament the following data are published. They show the production contracts under way with private industry, the companies engaged in educational orders, and those having production studies. All data were compiled as of July 15, 1940. Subsequent orders have been many and large; they will be included in future tabulations to be published in these pages. The following include only production contracts with private industry and only those above $25,000 in value. They do not include orders placed with the six manufacturing arsenals. In the case of educational orders, the data include all orders of this kind under the 1940 program. Subsequent orders also will be listed in this journal. As the names imply, production contracts are orders for the immediate manufacture of military equipment; educational orders are trial orders to familiarize manufacturers with their duties in time of war, and production studies are engineering analyses by a given plant of the technique, equipment, and requirements for war-time quantity production.

Ordnance Production Contracts—Fiscal Year 1940

Facility	*Item*	*Amount*
Aetna-Standard Engineering Co., Youngstown, Ohio	37-mm. antiaircraft gun carriages	$ 3,302,139.67
Alliance Machine Co., Alliance, Ohio	Drop forging hammer	27,605.00
Allis-Chalmers Manufacturing Co., Milwaukee, Wis	Tractor cranes	61,825.00
American Brass Co., Waterbury, Conn	Cartridge brass cups	191,700.00
	Cartridge brass discs	131,823.46
American Car & Foundry Co., New York, N. Y	Light tanks	6,055,251.00
American Locomotive Co., New York, N. Y	Bomb bodies	25,509.75
American Manufacturing Co., Waterbury, Conn	Cartridge discs	47,833.00
Atlas Powder Co., Wilmington, Del	Powder assemblies	26,197.60
	TNT	776,098.80
Atwater Manufacturing Co., Plantville, Conn	Fuze adapters	72,971.54
Austin Hastings Co., Inc., Cambridge, Mass	Lathes	127,648.00
Auto-Ordnance Corporation, New York, N. Y	Submachine guns & parts	1,313,142.13
Baldwin Locomotive Works, Philadelphia, Pa	8-inch railway gun mounts	1,114,454.00
Bausch & Lomb Optical Co., Rochester, N. Y	Flank-spotting instruments	195,691.77
	Sights & parts	121,555.40
	Stereoscopic trainers	76,068.20
	Telescopic sights & parts	193,509.72
Bethlehem Steel Co., Bethlehem, Pa	Bomb bodies	2,667,924.05
	5-in. antiaircraft gun forgings	162,634.75
	8-in. armor-piercing projectiles	1,060,000.00
	8-in. gun liners	29,952.00
	37-mm. gun forgings	32,800.00
	75-mm. shell forgings	121,728.10
	105-mm. shells	407,095.00
	155-mm. gun tube forgings	61,535.00
Billings & Spencer Co., Hartford, Conn	Drop hammers	26,681.00
Bohn Aluminum & Brass Corporation, Detroit, Mich	Boosters (metal parts)	60,866.68
	Fuze bodies & caps	143,092.00
Breeze Corporations, Inc., Newark, N. J	Machine-gun control sets	775,991.36
Bridgeport Brass Co., Bridgeport, Conn	Cartridge brass discs	40,851.88
	75-mm. cartridge cases	716,800.00
Bridgeport Thermostat Co., Inc., Bridgeport, Conn	100-lb. practice bombs	98,067.50
Brown & Sharpe Manufacturing Co., Providence, R. I	Grinding machines	31,354.70
	Milling lathes	26,361.00
	Milling machines	92,329.00
	Screw machines	60,716.00
Budd Wheel Co., Detroit, Mich	81-mm. high-explosive shell	569,254.20
	81-mm. smoke shell	259,466.80

Ordnance Production Contracts—Fiscal Year 1940

Facility	*Item*	*Amount*
Camden Forge Co., Camden, N. J.	155-mm. gun breech-ring forgings	$ 48,287.80
Campbell Wyant & Cannon Foundry Co., Muskegon Heights, Mich.	60-mm. shell castings	98,880.00
Canister Co., Phillipsburg, Pa.	Fiber containers	330,715.29
Carbide & Carbon Chemical Corporation, New York, N. Y.	Alcohol recovery equipment	66,590.00
Carpenter Steel Co., Reading, Pa.	Bar steel	92,942.50
Caterpillar Tractor Co., Peoria, Ill.	Tractors	655,038.75
Cincinnati Milling Machine Co., Cincinnati, Ohio	Milling Machines	234,822.85
Clayton & Lambert Manufacturing Co., Detroit, Mich.	500-lb. bomb shipping-band assemblies	41,737.48
Cleveland Tractor Co., Cleveland, Ohio	Tractors	186,540.20
Colonial Broach Co., Detroit, Mich.	Broaching machines	35,665.00
Colt's Patent Fire Arms Manufacturing Co., Hartford, Conn.	Cal. .45 pistols	68,122.32
	Cal. .45 revolver parts	98,439.00
	37-mm. antiaircraft guns & parts	1,175,236.95
Combustion Engine Co., Inc., New York, N. Y.	Nitric-acid manufacturing equipment	376,000.00
Consolidated Machine Tool Co., Rochester, N. Y.	Boring mill	174,825.00
Continental Motors Corporation, Muskegon, Mich.	Tank engines	1,062,763.73
Coulter & McKenzie Machine Co., Bridgeport, Conn.	Pickling & washing machines	29,250.00
Crucible Steel Co. of America, New York, N. Y.	5-in. antiaircraft shell forgings	80,868.75
	8-in. gun liner forgings	47,125.00
Cunningham Son & Co., James	Cal. .50 machine-gun carriage assemblies	62,856.00
Delco Appliance Division (G. M. C.), Rochester, N. Y.	37-mm. antiaircraft gun control sets	769,034.00
Diebold Safe & Lock Co., Canton, Ohio	60-mm. mortar & mount (spare parts)	27,580.40
Disston & Sons, Inc., Henry, Philadelphia, Pa.	Armor plate	1,455,772.85
Du Pont de Nemours & Co., Inc., E. I.	Ammonium nitrate	250,000.00
	Smokeless powder	4,001,199.51
	Tetryl	253,040.00
	TNT	2,100,850.00
Eastman Kodak Co., Rochester, N. Y.	Panoramic telescopes	250,382.60
Eclipse Aviation Division (Bendix Aviation Corporation) Bendix, N. J.	Antiaircraft carriage equipment	53,607.00
	Azimuth & elevation instruments	1,013,955.40
	Data transmission systems	375,210.00
Eclipse Machine Division (Bendix Aviation Corporation), Elmira, N. Y.	Electrical equipment	229,659.87
	37-mm. practice shot	73,416.00
Electric Wheel Co., Quincy, Ill.	Bomb trailers	138,594.00
Essley Machinery Co., E. L., Chicago, Ill.	Drilling machines	26,229.90
	Honing and lapping machines	118,521.00
Ex-Cell-O Corporation, Detroit, Mich.	Shell-turning machines	62,649.00
Farquhar Co., Ltd., A. B., York, Pa.	81-mm. mortars & mounts	128,975.00
Federal Machinery Sales Co., Chicago, Ill.	Boring mills	35,650.00
Federal Screw Works, Detroit, Mich.	Adapters	118,800.00
	Fuze detonator sockets	36,870.00
Ferracute Machine Co., Bridgeton, N. J.	Horizontal presses	28,265.00
Firestone Tire & Rubber Co., Akron, Ohio	Rubber blocks & bushings	126,060.00
	Tires	44,082.00
Florence Pipe & Machine Co., Philadelphia, Pa.	Hydraulic valves	83,825.00
General Electric Co., Schenectady, N. Y.	75-mm. pack howitzers	764,654.00
	Sighting systems	386,683.20
Gilbert & Barker Manufacturing Co., Springfield, Mass.	37-mm. antiaircraft gun drive mechanisms	129,506.69
	Sighting systems	721,594.50
	Water chests	28,727.95
Goodyear Tire & Rubber Co., Akron, Ohio	Tires	28,792.40
Guiberson Diesel Engine Co., Dallas, Tex.	Tank engines	588,037.70
Hardings Brothers, Inc., Elmira, N. Y.	Lathes	65,599.70
Hanson-Whitney Machine Co., Hartford, Conn.	Machinery	26,176.32
Hercules Powder Co., Wilmington, Del.	Ammonium nitrate	126,690.00
	Nitrocellulose	780,190.60
	Smokeless powder	2,393,360.00
Hobart Brothers Co., Troy, Ohio	Generating units	34,850.00
Improved Mailing Case Co., New York, N. Y.	Fiber containers	221,567.50
Irving Air Chute Co., Inc., Buffalo, N. Y.	Bomb parachute assemblies	49,491.00

Ordnance Production Contracts—Fiscal Year 1940

Facility	*Item*	*Amount*
Jones & Lamson Machinery Co., Springfield, Vt.	Lathes	$ 265,332.00
Kearney & Trecker Corporation, Milwaukee, Wis.	Milling machines	121,570.10
Keuffel & Esser Co., Hoboken, N. J.	Height finders	1,273,327.50
Lansdowne Steel & Iron Co., Morton, Pa.	5-in. antiaircraft shell forgings	57,000.00
LeBlond Machine Co., R. K., Cincinnati, Ohio.	Lathes	113,990.00
Logansport Machine, Inc., Logansport, Ind.	Hydraulic shaving machine	31,779.00
Lundquist Tool & Manufacturing Co., Worcester, Mass.	Telescope mounts	50,450.00
Magor Car Corporation, New York, N. Y.	Trucks for 8-in. gun railway carriages	39,424.00
Meff, Kohlbusch & Bissell, Chicago, Ill.	Shears	36,587.00
Midvale Co., Philadelphia, Pa.	8-in. armor-piercing projectiles	757,500.00
	37-mm. antiaircraft gun barrels	428,736.00
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.	Sights and parts	138,485.26
	Telescopes	70,522.16
Monarch Machine Tool Co., Sidney, Ohio.	Lathes	128,775.20
Morton Manufacturing Co., Muskegon Heights, Mich.	Multipurpose machine	126,490.00
Motley Co., Inc., James M., New York, N. Y.	Drop hammers	29,965.00
Mueller Brass Co., Port Huron, Mich.	Brass forgings	134,150.00
National Broach & Machine Co., Detroit, Mich.	Profiling machines	24,960.00
National Pneumatic Co., Rahway, N. J.	37-mm. antitank guns	1,397,458.23
	37-mm. gun forgings	27,169.00
National Tube Co., Pittsburgh, Pa.	90-mm. shell forgings	42,657.30
	155-mm. shell forgings	134,384.25
Niles-Bement-Pond Co. (Division of General Machinery Corporation of Delaware), Hartford, Conn.	Chambering machines	28,036.00
	Gun-drilling machines	24,718.00
Niles Tool Works Co., Hamilton, Ohio.	Gun-boring lathes	73,107.13
Norris Stamping & Manufacturing Co., Los Angeles, Calif.	75-mm. cartridge cases	502,000.00
Norton Co., Worcester, Mass.	Grinders & wheels	132,426.11
Oliver Iron & Steel Corporation, Pittsburgh, Pa.	Eyebolt lifting plugs	37,216.70
Peco Manufacturing Co., Philadelphia, Pa.	Eyebolt lifting plugs	48,070.50
	Machining fuze bodies & caps	75,000.00
Pennsylvania Forge Corporation, Philadelphia, Pa.	4.2-in. chemical shell forgings	30,114.00
Pollak Manufacturing Co., Arlington, N. J.	Fuzes	160,200.00
	Percussion primers	423,600.00
Pottsville Casting and Machine Shops, Inc., Pottsville, Pa.	Metal bomb crates	53,609.83
Pratt & Whitney Division (Niles-Bement-Pond Co.), Hartford, Conn.	Lathes	66,016.00
	Milling machines	35,556.00
	Profilers	50,390.00
	Radial drills	32,250.00
	Reaming machines	34,200.00
Prentiss & Co., Inc., Henry, New York, N. Y.	Boring machines	353,052.25
	Milling machine	40,575.00
Read Machinery Co., York, Pa.	60-mm. mortars & mounts	187,830.00
Remington Arms Co., Bridgeport, Conn.	Cal. .22 cartridges	425,188.61
	Cal. .30 armor-piercing cartridges	952,350.00
	Cal. .30 tracer cartridges	568,948.04
Rettew Co., R. L., Lebanon, Pa.	155-mm. gun shell fuze adapters	68,541.00
Rivett Lathe & Grinder Co., Inc., Boston, Mass.	Lathes	28,015.00
Rockford Machine Tool Co., Rockford, Ill.	Shaper machines	36,639.00
Scovill Manufacturing Co., Waterbury, Conn.	Boosters (metal parts)	112,878.00
	Boosters	112,060.00
	37-mm. cartridge cases	302,937.00
	75-mm. cartridge cases	297,304.90
	Fuzes	213,925.00
	Fuzes (metal parts)	82,244.00
	Primer bodies	122,875.00
Seeley Tube & Box Co., Newark, N. J.	Fiber containers	51,960.00
Sellers & Co., Inc., William, Philadelphia, Pa.	Boring machines	44,204.00
	Multipurpose machines	105,255.00
Seneca Falls Machine Co., Inc., Seneca Falls, N. Y.	Lathes	26,085.40
Seth Thomas Clocks, Thomaston, Conn.	Fuze components	29,460.00
Shipley Machinery Co., W. E., Philadelphia, Pa.	Screw machines	42,793.50
Simplex Wire & Cable Co., Cambridge, Mass.	Conductor cable	22,242.75
Smith & Wesson Co., Springfield, Mass.	Cal. .45 revolver parts	92,588.00
Spencer Lens Co., Buffalo, N. Y.	Azimuth instruments & parts	160,039.02
	Telescopes	70,693.00

Ordnance Production Contracts—Fiscal Year 1940

Facility	*Item*	*Amount*
Sperry Gyroscope Co., Inc., Brooklyn, N. Y.	Aircraft directors & parts	$ 916,771.80
	Sound locators	4,181,786.16
Standard Pressed Steel Co., Jenkintown, Pa.	Percussion primers	28,380.43
	Primer heads	38,306.61
Stedfast & Roulston, Boston, Mass.	Boring mills	55,548.00
	Milling machines	176,820.00
Steel & Tube Division (Republic Steel Corporation), Cleveland, Ohio.	Burster casings	197,105.52
Stewart & Warner Corporation, Chicago, Ill.	Fuzes & components	381,705.20
Stokes Machine Co., F. J., Philadelphia, Pa.	Pelleting presses	47,760.00
Sullivan Machine Co., New York, N. Y.	Air compressor & measuring meter	33,291.62
Susquehanna Silk Mills, New York, N. Y.	Cartridge cloth	31,048.32
Timken-Detroit Axle Co., Detroit, Mich.	155-mm. gun bogie & limber assemblies	100,680.00
Tredegar Co., Richmond Va.	12-in. mortar practice projectiles	44,393.50
Trojan Powder Co., Allentown, Pa.	TNT	165,586.80
Warner & Swasey Co., Cleveland, Ohio.	Turret lathes	105,267.00
Waterbury Farrel Foundry and Machine Co., Waterbury, Conn.	Cartridge-loading machines	37,125.00
	Charging machine	32,600.00
	Vertical presses	27,750.00
Westclox Division (General Time Instrument Co.), La Salle, Ill.	Fuze components	34,460.00
Western Cartridge Co., East Alton, Ill.	Cal. .22 long-rifle cartridges	425,919.60
White Motor Co., Cleveland, Ohio.	Scout cars & parts	7,121,348.00
Winchester Repeating Arms Co., New Haven, Conn.	Cal. .30 M1 rifles	8,710,000.00
Wisconsin Axle Division (Timken Detroit Axle Co.), Oshkosh, Wis.	Power trains	397,205.80
	Syncromesh transmissions	92,535.35
Wright Aëronautical Corporation, Paterson, N. J.	Radial engines & parts	839,675.55
Yellow Truck & Coach Co., Pontiac, Mich.	Bomb service trucks	125,831.70
York Safe & Lock Co., York, Pa.	3-in. antiaircraft gun mounts	604,188.00
	Cal. .50 machine-gun cradle assemblies	57,050.00
	37-mm. armor-piercing shot	1,731,240.00
	37-mm. gun carriages	1,623,800.00

Ordnance Production Contracts—Fiscal Year 1941

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.	Tractors	$ 497,277.00
American Brass Co., Waterbury, Conn.	Rotating bands	34,000.00
American Car & Foundry Co., New York, N. Y.	Light tanks	11,496,951.00
American Forge Co., Chicago, Ill.	75-mm. shell forgings	203,480.00
Austin Powder Co., Bethlehem, Pa.	Spotting charges	132,600.00
Bausch & Lomb Optical Co., Rochester, N. Y.	Spotting instruments & rules	45,200.00
	Stereoscopic trainers	244,650.00
Bendix Aviation Corporation, Marine Division, Brooklyn, N. Y.	Range-correction boards	76,489.58
Bethlehem Steel Co., Bethlehem, Pa.	37-mm. gun breech-ring forgings	53,900.00
Bliss Co., E. W., Toledo, Ohio.	Cupping press	25,796.00
Breeze Corporations, Inc., Newark, N. J.	Cal. .50 machine-gun control sets	129,500.00
Bridgeport Brass Co., Bridgeport, Conn.	75-mm. cartridge cases	555,000.00
Brown & Sharpe Manufacturing Co., Providence, R. I.	Milling machines	195,527.88
Budd Wheel Co., Detroit, Mich.	3-in. shell	1,200,000.00
	81-mm. shell	449,000.00
	90-mm. shell	1,790,000.00
Bullard Co., Bridgeport, Conn.	Boring & turning machines	58,173.60
Cincinnati Milling Machine Co., Cincinnati, Ohio.	Milling machines	208,280.00
Colt's Patent Fire Arms Manufacturing Co., Hartford, Conn.	Cal. .45 pistol components	40,330.00
	Cal. .45 pistols	50,737.50
	Cal. .50 machine guns	981,291.68
Crucible Steel Co. of America, New York, N. Y.	8-in. howitzer tube forgings	117,098.25
Cummings Machine Works, Boston, Mass.	Range quadrants	27,000.00
Cunningham Son & Co., James, Rochester, N. Y.	Machine-gun carriages	215,180.00
Doehler Die Casting Co., Pottstown, Pa.	Die castings	56,340.00
Du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.	Smokeless powder	20,000,000.00
Eastman Kodak Co., Rochester, N. Y.	Panoramic telescopes	265,000.00
Eclipse Aviation Division (Bendix Aviation Corporation), Bendix, N. J.	Fire-control parts	793,330.00
Edgewater Steel Co., Pittsburgh, Pa.	8-in. howitzer breech-ring forgings	39,307.31

Ordnance Production Contracts—Fiscal Year 1941

Facility	*Item*	*Amount*
Electric Arc Cutting & Welding Co., Newark, N. J.	Generating units	$ 33,000.00
Ex-Cell-O Corporation, Detroit, Mich.	Shell-turning machines	52,280.00
General Electric Co., Schenectady, N. Y.	75-mm. pack howitzers	175,086.51
Gilbert & Barker Manufacturing Co., Springfield, Mass.	37-mm. gun sighting systems	441,000.00
Goodrich Rubber Co., Akron, Ohio	Flexible tracks	1,409,439.00
Harrisburg Steel Corporation, Harrisburg, Pa.	TNT	1,050,000.00
	Bomb bodies	1,961,832.00
Hercules Powder Co., Wilmington, Del.	Mortar propellants	266,000.00
Hoe & Co., R., New York, N. Y.	3-in. antiaircraft recoil systems	732,000.00
International Harvester Co., Chicago, Ill.	Tractors	2,260,373.54
International Nickel Co., New York, N. Y.	Copper-nickel rods & cylinders	27,736.11
Jones & Lamson Co., Springfield, Vt.	Base-facing machines	41,461.00
	Shell-turning machines	63,236.00
Kearney & Trecker Corporation, Milwaukee, Wis.	Milling machines	183,906.52
Kilgore Manufacturing Co., Tippecanoe City, Ohio	Flares & signals	493,890.00
Kingsbury Machine & Tool Corporation, Keene, N. H.	Drilling machines	35,485.00
	Fleximatic machines	28,675.00
Lapointe Machine Tool Co., Hudson, Mass.	Broaching machine	71,857.50
Mesta Machine Co., Pittsburgh, Pa.	Planer	135,000.00
Mueller Brass Co., Port Huron, Mich.	Primer heads	58,500.00
National Acme Co., Cleveland, Ohio	Spinning & turning machines	94,675.00
National Broach & Machine Co., Detroit, Mich.	Profiling machines	102,560.00
National Pneumatic Co., Rahway, N. J.	81-mm. mortars	133,231.50
Orinoca Mills, New York, N. Y.	Cartridge cloth	27,000.00
Peco Manufacturing Co., Philadelphia, Pa.	Lifting lugs	107,000.00
Prentiss & Co., Inc., Henry, New York, N. Y.	Boring mills	111,286.00
Read Machinery Co., York, Pa.	60-mm. mortars	278,452.38
Revere Brass & Copper Co., New Bedford, Mass.	Brass tubes & strips	155,300.00
Russakov Can Co., Chicago, Ill.	Practice bombs	117,300.00
Scovill Manufacturing Co., Waterbury, Conn.	Primer heads	667,500.00
	75-mm. cartridge cases	114,000.00
Smith Machine Co., H. A., Syracuse, N. Y.	Lathes	96,629.63
Sperry Gyroscope Co., Inc., Brooklyn, N. Y.	Antiaircraft directors	2,185,323.60
	Sound locators	642,997.80
Stewart & Warner Corporation, Chicago, Ill.	Fuzes	222,625.00
Stokes Machine Co., F. J., Philadelphia, Pa.	Compressing machines	29,481.00
Thompson Products Co., Detroit, Mich.	Fuze adapters	119,300.00
United Shoe Machinery Co., Boston, Mass.	37-mm. tank guns	1,316,485.60
U. S. Steel Corporation, New York, N. Y.	Armor plate	5,494,724.60
	3-in. antiaircraft projectiles	747,300.00
	8-in. howitzer projectiles	1,682,000.00
	75-mm. projectiles	3,063,750.00
	90-mm. antiaircraft projectiles	4,485,000.00
	155-mm. projectiles	6,954,000.00
	100-lb. bomb bodies	3,397,500.00
	300-lb. bomb bodies	5,804,250.00
	TNT	1,450,000.00
Universal Crusher Co., Cedar Rapids, Iowa	Cal. .50 machine-gun cradle assemblies	92,400.00
Warner & Swasey Co., Cleveland, Ohio	Milling machines	49,000.00
	Turret lathes	59,250.00
York Safe & Lock Co., York, Pa.	Cal. .30 machine-gun cradle assemblies	71,795.75
	3-in. antiaircraft gun mounts	1,290,936.15
	37-mm. gun carriages	184,860.00

Educational Orders—Fiscal Year 1940

Acushnet Process Co., New Bedford, Mass.	Optical mask	$ 37,520.00
American Car & Foundry Co., Berwick, Pa.	1000-lb. demolition bomb	81,167.00
American Forge Division (American Brake Shoe & Foundry Co.), Chicago, Ill.	90-mm. shell forgings	70,235.00
American Steel & Wire Co., New York, N. Y.	Field communication wire	6,864.00
Anaconda Wire & Cable Co., New York, N. Y.	Field communication wire	4,783.68
Anderson Co., A. & J. M., Boston, Mass.	3-in. cartridge case	116,040.00
Armstrong Cork Co., Lancaster, Pa.	Machining 75-mm. shell	81,311.34

Educational Orders—Fiscal Year 1940

Facility	*Item*	*Amount*
Babcock Printing Press Corporation, New London, Conn	Machining 90-mm. shell	$ 183,131.00
Backes' Sons, Inc., M., Wallingford, Conn	Parachute signals	7,522.12
Baldwin Locomotive Works, Philadelphia, Pa	Light tank	587,694.40
	155-mm. shell forgings	240,272.00
Barnebey-Cheney Engineering Co., Columbus, Ohio	Noncoconut charcoal	320,912.00
	Whetlerite	60,935.00
Beaird Corporation, J. B., Shreveport, La	Machining 75-mm. shell	108,919.59
Belden Manufacturing Co., Chicago, Ill	Field communication wire	6,916.80
Builders Iron Foundry, Providence, R. I	Telescope mount	105,509.94
Carlisle Lumber Co., Onalaska, Wash	Noncoconut charcoal	283,990.00
	Whetlerite	61,627.50
Chevrolet Motor Division (G. M. C.), Detroit, Mich	Machining 75-mm. shell	100,850.94
	75-mm. shell forgings	36,127.20
Chrysler Corporation, Detroit, Mich	Fuze	97,079.30
	Machining 75-mm. shell	110,616.50
	75-mm. shell forgings	67,732.00
	75-mm. cartridge case	154,082.40
Circle Wire & Cable Corporation, Maspeth, L. I., N. Y	Field communication wire	8,620.00
Collyer Insulated Wire Co., Pawtucket, R. I	Field communication wire	5,760.40
Colorado Fuel & Iron Co., Denver, Colo	155-mm. shell forgings	251,674.25
Consolidated Steel Corporation, Los Angeles, Calif	500-lb. demolition bomb	109,626.00
Continental Gin Company, Birmingham, Ala	Machining 75-mm. shell	72,521.40
Corbin Screw Corporation, New Britain, Conn	Fuze	29,340.60
Cowdrey Machine Works, C. H., Fitchburg, Mass	75-mm. pack howitzer	174,208.50
Crescent Insulated Wire & Cable Co., Trenton, N. J	Field communication wire	4,919.80
Crucible Steel Co. of America, New York, N. Y	37-mm. shot	113,236.41
Cummings Machine Works, Boston, Mass	Range quadrant	51,587.50
Darling Valve & Manufacturing Co., Williamsport, Pa	Machining 75-mm. shell	58,902.63
Dresser Manufacturing Co., Bradford, Pa	81-mm. shell forgings	3,993.30
Duraloy Company, Scottdale, Pa	Centrifugal castings	148,920.00
Eastman Kodak Co., Rochester, N. Y	Height finder	394,833.91
	Telescope	34,566.01
	Aiming circle	104,411.68
Electric Household Utilities Corporation, Chicago, Ill	Booster (metal components)	42,656.60
Elgin National Watch Co., Elgin, Ill	Fuze	479,178.12
Essex Specialty Co., Inc., Berkley Heights, N. J	Parachute signals	6,791.93
Federal Screw Works, Detroit, Mich	Booster (metal components)	59,795.28
	Fuze	72,040.85
Ferro Machine & Foundry Co., Cleveland, Ohio	3-in. shell	109,968.00
Firestone Tire & Rubber Co., Fall River, Mass	Gas masks	328,329.00
	Molded gas-mask facepiece	58,130.00
Fulton Sylphon Co., Knoxville, Tenn	Fuze	101,991.00
General Electric Co., Schenectady, N. Y	Field communication wire	5,385.60
General Iron Works, Denver, Colo	Machining 155-mm. shell	115,455.00
General Railway Signal Co., Rochester, N. Y	Machining 75-mm. shell	112,560.28
Goodyear Tire & Rubber Co., Akron, Ohio	Gas-mask carrier	88,166.00
	Molded gas-mask facepiece	58,010.00
Grayson Heat Control, Ltd., Lynwood, Calif	Fuze	98,092.43
Guide Lamp Division (G. M. C.), Detroit, Mich	3-inch cartridge case	149,362.81
Harrington & Richardson Arms Co., Worcester, Mass	Cal. .45 automatic pistol	192,497.50
Hazard Insulated Wire Works Division. (Okonite Co.), Wilkes-Barre, Pa	Parachute signals	4,868.16
Hobart Mfg. Co., Troy, N. Y	Telescope mount	46,099.59
Holtzer-Cabot Electric Co., Boston, Mass	Telephone	43,482.63
Johnson & Johnson, Chicago, Ill	Gas masks	347,714.00
Kellogg Switchboard & Supply Co., Chicago, Ill	Telephone	36,938.27
Kemper-Thomas Co., Cincinnati, Ohio	Noncombatant gas masks	138,520.00
Key Co., East St. Louis, Ill	Machining 155-mm. shell	164,205.30
Kilby Steel Co., Anniston, Ala	Shell forging	113,228.62
Kilgore Manufacturing Co., Tippecanoe City, Ohio	Parachute flare	13,331.50
Kingston Products Corporation, Kokomo, Ind	Machining 75-mm. shell	45,062.70
Line Material Co., Milwaukee, Wis	Shell	104,432.49
Measuregraph Co., St. Louis, Mo	Gunner's quadrant	26,926.28

Educational Orders—Fiscal Year 1940

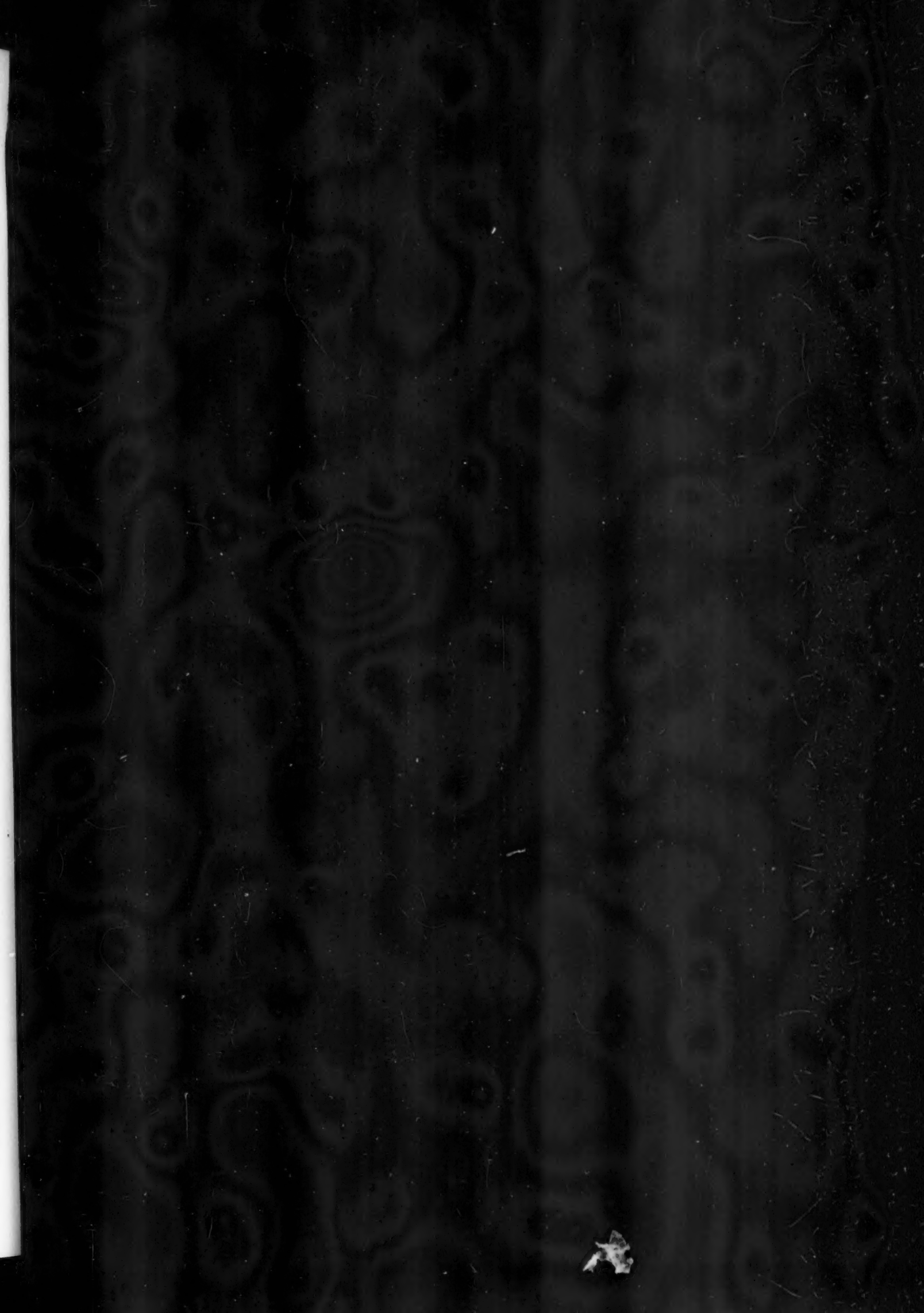
Facility	*Item*	*Amount*
Mergenthaler Linotype Co., Brooklyn, N. Y.	Aiming circle	$ 128,953.29
	Azimuth instrument	152,146.50
	Panoramic telescope	99,557.92
Milwaukee Stamping Co., Milwaukee, Wis.	Canister components	251,089.00
Minneapolis-Moline Power Implement Co., Minneapolis, Minn.	Machining 155-mm. shell	141,142.60
Motor Wheel Corporation, Lansing, Mich.	3-in. shell	67,108.20
Murray Co., Atlanta, Ga.	Machining 75-mm. shell	91,206.35
National Cash Register Co., Dayton, Ohio	Fuze	71,332.99
National Fireworks, Inc., Boston, Mass.	Parachute flare	13,431.00
National Pneumatic Co., Rahway, N. J.	Booster (metal components)	62,745.63
New Haven Clock Co., New Haven, Conn.	Fuze	410,577.00
New York Air Brake Co., New York, N. Y.	Machining 75-mm. shell	79,552.31
Norris, Inc., W. C., Tulsa, Okla.	Machining 81-mm. shell	76,689.59
Norwalk Lock Co., South Norwalk, Conn.	37-mm. shot	125,998.19
Omaha Steel Works, Omaha, Nebr.	Machining 155-mm. shell	161,658.00
Philadelphia Storage Battery Co., Philadelphia, Pa.	Fuze	133,485.64
Pittsburgh Forging Co., Coraopolis, Pa.	75-mm. shell forgings	36,364.88
Precision Manufacturing Co., Philadelphia, Pa.	Telescope mount	68,120.00
Pressed Steel Car Co., Pittsburgh, Pa.	75-mm. shell forgings	119,832.00
Pullman Standard Car Manufacturing Co., Pittsburgh, Pa.	105-mm. shell forgings	81,990.80
	Machining 105-mm. shell	171,997.00
Roebling's Sons Co., John A., New York, N. Y.	Field communication wire	6,148.30
Rome Cable Corporation, Rome, N. Y.	Field communication wire	7,249.44
Saginaw Steering Gear Division (G. M. C.), Saginaw, Mich.	Cal. .30 machine gun	726,004.00
Scott & Co., Walter, Plainfield, N. J.	Recoil mechanism	445,494.72
Scovill Manufacturing Co., Waterbury, Conn.	Fuze	153,152.00
Singer Manufacturing Co., Elizabeth, N. J.	Cal. .45 automatic pistol	278,875.67
Spencer Lens Co., Buffalo, N. Y.	Height finder	363,449.22
Sprague Specialties Co., North Adams, Mass.	Noncombatant gas masks	171,907.77
Stockham Pipe Fittings Co., Birmingham, Ala.	Machining 75-mm. shell	69,957.62
Stromberg-Carlson Telephone Manufacturing Co., Rochester, N. Y.	Telephone	48,484.88
Sunbeam Electric Manufacturing Co., Evansville, Ind.	Booster (metal components)	77,856.78
Taylor-Wharton Iron & Steel Co., Easton, Pa.	155-mm. shell forgings	129,770.25
Tennessee Coal, Iron, & Railway Co., Birmingham, Ala.	75-mm. shell forgings	123,759.50
Triumph Explosives, Inc., Elkton, Md.	Parachute signals	5,660.00
Tuthill Pump Co., Chicago, Ill.	Gunner's quadrant	41,513.07
Unexcelled Manufacturing Co., Reading, Ohio	Parachute signals	8,241.25
U. S. Machine Corporation, Lebanon, Ind.	Machining 75-mm. shell	35,155.83
United States Rubber Co., New York, N. Y.	Field communication wire	6,781.00
Van Dorn Iron Works, Cleveland, Ohio	Light tank hulls	185,244.95
Vogt Machine Co., Henry, Louisville, Ky.	Machining shell	185,155.85
Waltham Watch Co., Boston, Mass.	Fuze	356,085.00
Warren Webster & Co., Camden, N. J.	Booster (metal components)	34,656.37
Western Cartridge Co., East Alton, Ill.	Cal. .50 tracer cartridge	454,798.21
Wheland Co., Chattanooga, Tenn.	Machining 75-mm. shell	66,758.67
Wright Machine Co., Worcester, Mass.	Booster (metal components)	74,238.50

Ordnance Production Studies—Fiscal Year 1940

Facility	*Item*
Acklin Stamping Co., Toledo, Ohio	37-mm. cartridge case
Allegheny Ludlum Steel Corporation, Breckenridge, Pa.	3-in. and 105-mm. cartridge cases
Allied Products Corporation, Detroit, Mich.	60-mm. mortar & mount
American Locomotive Co., New York, N. Y.	500-lb. demolition bomb
American Type Founders, Inc., Elizabeth, N. J.	75-mm. pack howitzer recoil mechanism
Anglo-American Mill Corporation, Inc., Owensboro, Ky.	81-mm. mortar & mount
Black & Decker Manufacturing Co., Towson, Md.	Booster
Blaw-Knox Co., Blawnox, Pa.	155-mm. gun carriage
Bossert Co., Inc., Utica, N. Y.	75-mm. cartridge case
Bridgeport Brass Co., Bridgeport, Conn.	3-in. and 37-mm. cartridge cases
Brill Co., J. G., Philadelphia, Pa.	75-mm. shell forging

Ordnance Production Studies—Fiscal Year 1940

Facility	*Item*
Carter Carburetor Corporation, St. Louis, Mo	Fuze (metal parts)
Case Co., J. J., Racine, Wis	Machining 155-mm. shell
Colson Corporation, Elyria, Ohio	Tripod mount
Colt's Patent Fire Arms Manufacturing Co., Hartford, Conn	Cal. .45 automatic pistol; cal. .30 and cal. .50 machine guns
Consolidated Car Heating Co., Albany, N. Y	Fuze (metal parts)
Continental Gin Co., Birmingham, Ala	Cal. .50 antiaircraft machine-gun mount
Darling Valve & Manufacturing Co., Williamsport, Pa	Machining 75-mm. shell
Emerson Electric Manufacturing Co., St. Louis, Mo	Boosters
Federal Cartridge Corporation, Minneapolis, Minn	Primers
Gardner Denver Co., Denver, Colo	Machining 37-mm. shell
Goslin Birmingham Manufacturing Co., Birmingham, Ala	Machining 155-mm. shell
Harnischfeger Corporation, Milwaukee, Wis	75-mm. gun carriage
Harrisburg Steel Corporation, Harrisburg, Pa	300-lb. demolition bomb
Harvey Machine Co., Los Angeles, Calif	Cal. .50 antiaircraft machine-gun mount
Herschede Hall Clock Co., Cincinnati, Ohio	Antiaircraft observation, flank-spotting, and azimuth instruments
Hobart Manufacturing Co., Troy, Ohio	Range quadrant; sight; telescope mount
Hughes Tool Co., Houston, Tex	Forging and machining 75-mm. shell
Independent Lock Co., Fitchburg, Mass	Fuze (metal parts)
Ingersoll Steel and Disc Division (Borg-Warner Corporation) Chicago, Ill	Metallic belt links
Laclede Steel Co., Alton, Ill	155-mm. chemical-shell forging
Landis Machine Co., St. Louis, Mo	Fuze (metal parts)
LeTourneau Co. of Georgia, Atlanta, Ga	Machining 155-mm. shell
Liebel Flarsheim Co., Cincinnati, Ohio	Fuze hand setter
Lieberknecht, Inc., Karl, Reading, Pa	Range quadrant; telescope mount
Massey Harris Co., Racine, Wis	37-mm. antiaircraft mount
Morgan Construction Co., Worcester, Mass	75-mm. cartridge case
Mullins Manufacturing Corporation, Warren, Ohio	75-mm. cartridge case
Nash Engineering Co., South Norwalk, Conn	81-mm. mortar and mount
Nash-Kelvinator Corporation, Detroit, Mich	cal. .45 automatic pistol
National Cash Register Co., Dayton, Ohio	Fuze (metal parts); 37-mm. armor-piercing shot
National Pneumatic Co., Rahway, N. J	37-mm. tank gun
National Supply Co., Torrence, Calif	75-mm. gun carriage
Otis Elevator Co., Yonkers, N. Y	3-in. antiaircraft gun mount and recoil mechanism
Pullman Standard Car Manufacturing Co., Butler, Pa	75-mm. and 155-mm. shell forging
Remington Arms Co., Ilion, N. Y	cal. .30 M1, rifle; cal. .30, machine gun
Revere Copper & Brass Co., Baltimore, Md	37-mm. and 75-mm. cartridge cases
Schlage Lock Co., San Francisco, Calif	Aircraft shell cartridge case
Schrader's Sons, A., Brooklyn, N. Y	Fuze
Schwitzer Cummins Co., Indianapolis, Ind	37-mm. cartridge case
Scripto Manufacturing Co., Atlanta, Ga	Booster (metal parts)
Servel, Inc., Evansville, Ind	Machining 81-mm. shell
Solar Sturges Co., Melrose Park, Ill	37-mm. cartridge case
Soulé Steel Co., San Francisco, Calif	75-mm. howitzer carriage
Taylor Forge & Pipe Works, Chicago, Ill	155-mm. shell forging
Taylor-Wharton Iron & Steel Co., Easton, Pa	75-mm. shell forging
Tennessee Coal, Iron and Railway Co., Birmingham, Ala.	155-mm. shell and 75-mm. gun tube forgings; machining 155-mm. shell
Textile Machine Works, Reading, Pa	Panoramic telescope and mount
Tokheim Oil Tank & Pump Co., Fort Wayne, Ind	75-mm. cartridge case
Transue & Williams Steel Forging Corporation, Alliance, Ohio	75-mm. shell forging
Trico Products Corporation, Buffalo, N. Y	Fuzes (metal parts)
Union Switch & Signal Co., Swissvale, Pa	Machining 105-mm. shell
Wagner Electric Corporation, St. Louis, Mo	Fuzes (metal parts)
Weatherhead Co., Cleveland, Ohio	Fuzes (metal parts)
Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.	Machining 75-mm. shell using extant equipment; machining 75-mm. shell using single-purpose machine tools for full-time commitment
West Point Foundry & Machine Co., West Point, Ga	Tripod mount
Wood Newspaper Machinery Corporation, Plainfield, N. J	155-mm. howitzer recoil mechanism
Worcester Stamped Metal Co., Worcester, Mass	37-mm. cartridge case
Worthington Pump & Machinery Corporation, Harrison, N. J	3-in. antiaircraft gun mount



ARMY ORDNANCE

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Month by Month

THE RETURN OF COL. HENRY L. STIMSON TO his old post as Secretary of War is an historic occurrence of extraordinary import. From the Army Ordnance Association there is special felicitation because Colonel Stimson served as counsel to our board of directors from 1927 to 1929. To have held the office of Secretary of War with distinction is an achievement; but to add to that record eminent public service as Secretary of State and in the fields of diplomacy and international affairs, and now to return to the War Department for emergency service is indeed historic. Little wonder that the Army looks to its new head with confidence and reassurance. The Association tenders to Colonel Stimson, as it has to his predecessors whose line began with the renowned Newton D. Baker, a full measure of helpfulness and coöperation at all times and upon all occasions.

A similar welcome is extended to the new Assistant Secretary of War, Hon. Robert P. Patterson. Judge Patterson is a soldier who has known the field of battle. As a captain (later he was a major) in the 360th Infantry, A.E.F., he was awarded the Distinguished Service Cross for extraordinary heroism in action on August 14, 1918. A graduate of Harvard Law School, class of 1915, he was admitted to the New York Bar and practiced his profession in New York City until his appointment by President Hoover as judge of the United States District Court, Southern District of New York, in 1930. In 1939 he was elevated by President Roosevelt to the United States Circuit Court of Appeals for the Second Judicial District.

In welcoming the new Assistant Secretary, the splendid service of his predecessor, Col. Louis Johnson, is not forgotten. Colonel Johnson gave to industrial preparedness an impetus as great as any it has ever known. His vitality and energy were instrumental in bringing about the present satisfactory state of industrial mobilization—a condition for which the people of the country should be especially grateful.

Yet another friend of the Ordnance cause has been called to high duty in the person of the new Secretary of the Navy, Col. Frank Knox. Colonel Knox has many friends, especially among the Chicago contingent, in our society. His ability in other fields and his personality are qualities which will stand our Navy in good stead at this time, for he is a deep-water realist.

Coming closer to ordnance in the present scene, one of our own vice-presidents, Col. Frederick H. Payne, former Assistant Secretary of War, recently has been appointed chief of the Hartford Ordnance District succeeding the late Col. Benjamin A. Franklin. Colonel Payne is one of the best known and best qualified advocates of armament preparedness. An industrialist of long experience, Colonel Payne served as a commissioned officer of the Ordnance Department in the Bridgeport Ordnance District during the World War. When the Ordnance district system was reëstablished in 1922, he was appointed assistant chief of the district, which position he continued to hold until his appointment as Assistant Secretary of War in 1930. Following his retirement from that office, Colonel Payne returned to his former assignment as assistant district chief. In his writings and addresses throughout the country, Colonel Payne has been an outspoken advocate of industrial preparedness in all its branches. His interest in the cause never has wavered. The Army Ordnance Association frequently has thanked him publicly for his services and through these columns now congratulates him most sincerely on his new appointment.

Such personnel developments as the above are cause for sincere gratification on the part of all citizens whose prime concern at the moment is the adequacy of national defense. These men are not dreamers—they are doers whose records loudly proclaim their success in these and kindred fields. It is a fortunate circumstance for the fighting forces as well as for the nation as a whole that the administrative functions of national defense are in such hands and that those hands are upheld most enthusiastically by the services and by industry. To an observer on the Washington front these days, the degree of coöperation between industry—management and labor on the one hand, the National Defense Commission, the Army and Navy on the other—and the Congress, augurs well for the success of the gigantic armament effort on which we are now embarked.

APPROXIMATELY 139 NEW PLANTS FOR THE manufacture of ordnance, chemical warfare, aircraft and quartermaster equipment would be required as reserve production capacity for a major war effort, *i.e.* an Army of 2,000,000 men. Seventy-six would be required by the ordnance program, 33 would be for aircraft, 28 for chemical warfare equipment and 2 for quartermaster items. In some cases this reserve production capacity will be major additions to existing plants. In the case of those under the Chief of Ordnance many will be entirely new including plant sites.

Maj. Gen. C. M. Wesson, Chief of Ordnance, testifying before the House Committee recently, said that discussions already are under way with General Motors Corporation and Chrysler Corporation looking toward the construction of plants for the manufacture of aircraft cannon.

A summary of the plants considered necessary to be built to provide additional production capacity for a major national defense effort was presented to Congress by Col.

James H. Burns, Ord. Dept., executive officer to the Assistant Secretary of War, as follows:

Ordnance Plants

No.	Purpose	Total cost
4	Smokeless powder	$188,000,000
4	TNT	42,000,000
2	Tetryl	6,000,000
2	Picric acid and explosive D	8,000,000
2	Cotton purification	6,000,000
2	Ammonium nitrate	18,000,000
1	Ammonia	15,000,000
18	Shell and bomb loading:	
	75 millimeter	108,000,000
	155 millimeter	
5	Bag loading	26,000,000
2	Fuze loading	10,000,000
2	Small arms ammunition	7,000,000
6	Machine gun and airplane cannon:	
	50 caliber	36,000,000
	30 caliber	
1	Shell machining:	
	75 millimeter	8,500,000
	155 millimeter	
2	Armor plate	8,000,000
4	Ammunition metal components	12,000,000
3	Proving grounds	28,000,000
6	Existing manufacturing depots	19,000,000
10	Existing ordnance depots	12,500,000
	Total Ordnance Department	$558,000,000

Chemical Warfare Service

1	Existing arsenal	$ 4,000,000
1	New arsenal	26,500,000
26	Commercial plants	9,000,000
	Total Chemical Warfare Service	$ 39,500,000

Quartermaster Corps

2	Existing manufacturing depots	$ 5,500,000

Air Corps (Basis of 50,000 Military Airplanes a Year)

30	Airframe plants	$300,000,000
3	Engine plants	60,000,000
	Total, Air Corps	$360,000,000
	Grand total	$963,000,000

Two hundred million dollars has already been appropriated for these purposes. Additional funds to the extent of $325,000,000 are provided in the supplemental bill which (at this writing) has been passed by the House of Representatives.

Adequate armament defense clearly includes sufficient production capacity especially in noncommercial categories. It can be seen from the above list that the ordnance deficiencies are in those kinds of facilities for which no commensurate private capacity exists. This is notably true of artillery ammunition: shell, powder and explosives, and loading plants. These shadow factories in competent hands will supplement the established arsenals, proving grounds and loading plants. With good judgment the location of such plants will be determined strategically, having in mind protection from attack and adequacy of supplies.

THE WAR DEPARTMENT ANNOUNCED ON AUGust 7, 1940, that in order to increase employment and facilitate production, the Secretary of War had directed that the six Ordnance manufacturing arsenals put into effect, beginning on August 10th, a 3-shift basis, employing all available skilled labor for this purpose. This arrangement is authorized temporarily to obtain maximum production of needed war supplies from these establishments. During the continuance of the program, the laborers and mechanics will be paid time and a half for time worked over forty hours a week. The result will be three shifts of eight hours a day, six days a week. This will apply to laborers and mechanics at the following manufacturing establishments: Rock Island Arsenal, Rock Island, Ill., which now has a total of approximately 5,500 employees; Watertown Arsenal, Watertown, Mass., which now employs about 2,200; Frankford Arsenal, Philadelphia, Pa., which now has approximately 4,700 employees; Springfield Armory, Springfield, Mass., which now has about 3,200 employees; Picatinny Arsenal, Dover, N. J., which now employs approximately 3,800, and Watervliet Arsenal, Watervliet, N. Y., which now has approximately 1,800 employees. This action was taken after full conference with Commissioner Hillman of the Advisory Committee to the Council of National Defense, and with the approval of the President. It will make possible the employment in these arsenals of over 8,000 additional skilled mechanics and the further employment of possibly double that number of semi-skilled and unskilled personnel. It is expected that these measures will result in an increase in production of at least sixty-five per cent.

BY APPOINTMENT OF THE PRESIDENT, JULY 2, 1940, Lieut. Col. R. L. Maxwell, former secretary of the Army Ordnance Association and editor of this journal, was designated administrator of export control to administer the provisions of Section 6 of the act of Congress entitled "An Act to Expedite the Strengthening of the National Defense." The act provides legal authority for the control of exports from the United States, of munitions, materials, and machinery essential to our national defense. The items and materials which come within the jurisdiction of the act have been set forth in Presidential proclamation. They include certain strategic materials as well as semifinished products and machine tools of which there are actual or prospective shortages for our defense program. The materials and production divisions of the National Defense Advisory Commission are in collaboration with the Administrator of Export Control in the determination of the items to be controlled and the extent and character of the controls to be exercised.

While the control of exports is primarily a national-defense matter, the Department of State provides the machinery for the actual issue of licenses under which any controlled items are released for export. These controls supersede those formerly exercised by the Munitions Control Board. Arms, ammunition and implements of war as previously defined are included under the present controls.

The new Administrator of Export Control is an officer of energy and discrimination. These qualities he has shown on countless occasions, one of which was the period 1925-1926, when as secretary of the Army Ordnance Association and editor of this journal he increased the strength of both.

Industrial Mobilization

An Editorial

INDUSTRIAL mobilization is in full swing. The Congress has authorized the largest defense programs in the peace-time history of our country. The fighting forces have responded with well-laid plans for personnel and matériel ready for instant application. Labor and management have taken their places in the line of action. All told, the effort now under way is commendable. The content and scope of that effort is not new to the Army and Navy, but there are features of it which may impress the layman as novel. Thus far, there has been no departure in any essential from the plans which have been developed under professional military auspices in recent times. The years of effort devoted to industrial preparedness, military training, and service coordination were well spent. The industrial mobilization now under way is ample proof of this very satisfying truth.

Elsewhere in this issue are published the names of the principal manufacturing concerns which are now participating in the Ordnance program. This list is presented as good evidence of the progress already made in one field of defense; namely, military armament. It is our purpose during the current emergency to supplement this list from time to time that those companies which are at work may be known and, more important, that the speed with which the Ordnance Department of the Army is carrying the program forward may have the fullest understanding on all sides. As has been said before, production and yet more production are the needs of the hour. The imposing lists on pages 129 to 136 of this issue are the best evidence of what has been done in a very short period of time. They indicate production in addition to the tremendous loads being carried by Ordnance arsenals. They are also dependable indications of greater effort to come.

Delays thus far have been those of law rather than of men. Notable among these are the severe restrictions on plant and equipment amortization under which manufacturers would assume a heavy penalty for their contributions to the defense program. At this writing, steps are being taken by the Congress to replace such restrictions by more reasonable provisions. This helpful attitude also applies to the broader subjects of hours of labor, conditions of fair competition, etc. But there remains the urgent necessity of calling an armistice on the pettifogging attitude of some other branches of government which do not seem to know the urgency of the times. We insist and repeat that it is folly for representatives of the fighting services to ask unlimited effort on the part of individuals and commercial organizations in prosecuting the defense program and at the same time to have those same individuals and organizations hampered by criminal charges over technicalities and dreamy-eyed restrictions which are not only untimely but are grossly unfair. Either we prepare for national defense or we don't—military necessity knows no middle ground.

Industrial mobilization connotes more than the mere mobilization of industry. The term also means that full production must be achieved *in the very minimum of time*. If our present effort could lackadaisically wander on for the next ten years, there would be no need for much concern on anybody's part about it. And the present effort has a decidedly definite time factor. "Maximum production in minimum time" states the case in five words. But there is a minimum beyond which that factor cannot be reduced. Experts in industrial preparedness have repeatedly emphasized, year in and year out, that a maximum military effort would require from eighteen months to two years to reach peak performance. This is so in the nature of things. Much can be done to expand the time required, but little can be done to contract it. Anyone with the slightest experience in industrial production knows this to be true. It is not an invention of military and naval men seeking added time. It is in the nature of quantity production of armament.

WHEN Maj. Gen. C. M. Wesson, Chief of Ordnance, estimates that the current program will run through two years—*i.e.*, until 1942—he is only postulating a fact with which any industrialist or engineer similarly placed would agree. Great industrialists and engineers have concurred in this estimate. William P. Kirk, vice-president of Pratt & Whitney, manufacturers of aircraft engines, speaking at Litchfield, Conn., estimated that the manufacturing phase of the national-defense program will take between a year and a half and two years to get into full motion.

Alfred P. Sloan, Jr., chairman, General Motors Corporation, holds that while there can be no question of the potential ability of American industry to produce whatever may be asked of it, the question is not one of potentialities but is simply one of the essential time necessary to put new types of equipment into production.

A. W. Robertson, chairman, Westinghouse Electric & Manufacturing Company, having enlisted his great organization for the duration of the preparedness effort, emphasized the extreme importance of getting started at once. "The manufacture of new products cannot be commenced until necessary facilities have been obtained, engineering development and production studies completed, and men trained. In some kinds of production this takes many months." Mr. Robertson estimated the time required by his organization for full production (depending on quantities) for the manufacture of shells would be from 6 to 24 months; fuzes, 12 to 15 months; gun mounts, 4 to 24 months.

There is much to be done, of course. New plants are to be built in strategic areas; facilities are to be expanded; technicians are to be trained; military organization is to be raised to the highest peak of efficiency and training. The civilian needs of the country must be met. To assure success in all these fields, industrial mobilization is now under way. Fortunate indeed is the country that can boast the will and the ability to face the task. Now that the world is embarked upon times in which military necessity will govern international relations, there is added reason for the hope that this mobilization so auspiciously begun will continue in the same tempo. Its greatest impetus at the moment will be a tolerant understanding of the inherent difficulties involved and a willingness to simplify rather than to complicate them. Thus far, exemplary willingness to get the job done is being shown on all sides, and in that attitude alone will there be ultimate success.

L. A. C.

Association Affairs

ELECTION OF OFFICERS

AS announced in the last issue of this journal, the biennial election of officers and three national directors of the Association for terms beginning January 1, 1941, will be held by letter ballot in accordance with the Association's constitution on Tuesday, September 3, 1940. Ballots containing the names of the nominees proposed by the nominating committee were mailed to all members July 23rd.

The nominees have been identified with the Association since its organization in 1919. As well for the happy recollection of old members as to acquaint new ones, the following brief biographical data are published regarding the nominees:

BRIG. GEN. BENEDICT CROWELL was the Assistant Secretary of War and Director of Munitions during the World War. He was one of the founders of the Army Ordnance Association and its first and only president. His service has continued uninterruptedly since October 1, 1919.

General Crowell received his early education at St. Paul's School, Concord, N. H., and was graduated from Yale University from which he also received an honorary degree in 1918. By profession a mining engineer, General Crowell's first service to the national defense was his assistance to the General Munitions Board in 1917 in its important analysis of steel production in the United States. He was a member of the Kernan Board which, under the National Defense Act of 1916, conducted an investigation of the "feasibility, desirability and practicability of Government manufacture of arms, munitions and equipment." He was commissioned a major in the Reserve Corps and placed in charge of the Washington office of the Panama Canal where he served until his resignation to accept appointment as the Assistant Secretary of War in November 1917.

As Director of Munitions, General Crowell was responsible for the purchase of arms and equipment for our military forces, and his conduct of this great responsibility in one of the highest administrative positions in the United States during the World War won for him respect and admiration. The record of his service is told in an official report submitted after the termination of the war, "America's Munitions 1917-1918," and in the 6-volume work "How America Went to War" (prepared in collaboration with Capt. Robert Forrest Wilson). He is the coauthor (with Charles B. Murray) of "Iron Ores of Lake Superior." He was commissioned a brigadier general in the Ordnance Reserve in 1931. Last year he served as chairman of a special War Department board on educational orders. He is president of the Central National Bank of Cleveland, Ohio.

COL. WILLIAM W. COLEMAN of Milwaukee, Wis., a nominee for one of the two vice-presidencies, was a special assistant to the Chief of Ordnance, U. S. Army, in charge of the vast artillery-production program during the World War. He was commissioned a colonel in the Reserve Corps. A native of Maryland, Colonel Coleman was graduated from Lehigh University and began his metallurgical engineering practice with the Bethlehem Steel Company, later being associated with the Crucible Steel Company and Latrobe Steel and Coupler Company. His long service with the Bucyrus Company, manufactures of machinery, began in 1905. He became president of the company in 1911 and later of its successor, the Bucyrus-Erie Company of South Milwaukee. He is a director of the Marshall and Ilsley Bank, the Milwaukee Electric Light and Railway Company, Nordberg Manufacturing Company, the American Brake Shoe and Foundry Company, Oil Gear Company, and a trustee of the Northwestern Mutual Life Insurance Company. He has served as a vice-president of the Association since 1919 and as president of its Milwaukee Post since 1928.

COL. FREDERICK H. PAYNE, a nominee for vice-president, was the Assistant Secretary of War in the administration of President Hoover from 1930 to 1933. Commissioned a major in the Ordnance Department in 1918, he was procurement officer of the Bridgeport Ordnance District and of the Bridgeport District Claims Board. In the postwar organization of the Bridgeport District, Colonel Payne became assistant chief, serving continuously from 1919 to 1930. He resumed these duties at the termination of his service as the Assistant Secretary of War in 1933. He was appointed chief of the District in July, 1940.

Colonel Payne was born in Greenfield, Mass., and received his education in the schools of that city. He became a state bank examiner in 1906. He was president of the Mechanics Trust Company, Boston, and later vice-president of the Federal Trust Company. He was successively treasurer, vice-president, president, and chairman of the board of the Greenfield Tap & Die Corporation from 1912 to 1930, during which period he was for a time a partner of Tucker Anthony & Company, investment bankers of New York and Boston. He is now president of the Greenfield Tap & Die Corporation. He has served as a vice-president of the Army Ordnance Association since 1937 when he succeeded the late Col. William C. Spruance.

COL. FRANK A. SCOTT of Cleveland, Ohio, a nominee for director, was the first chairman of the General Munitions Board and of the War Industries Board in 1917. His early education was in his native city and under the tutelage of John H. Dynes of Western Reserve University, which institution awarded him the degree LL.D. in 1926. His first business connection was as assistant secretary and secretary of the Cleveland Chamber of Commerce and later secretary and treasurer of Superior Savings and Trust Company. In 1908 he became associated with Warner and Swasey Company, manufacturers of precision instruments, occupying the offices successively, from 1909 to 1927, of secretary and treasurer, vice-president, president, and chairman of the board.

Colonel Scott, at the request of the Secretary of War, undertook the arduous task of mobilizing American industry for war service in 1917. These duties were so great that failing health compelled his retirement as chairman of the War Industries Board in 1917. In 1919 he was awarded the Distinguished Service Medal for meritorious service. Commissioned colonel in the Ordnance Reserve, he served as chief of the Cleveland Ordnance District from 1924 to 1928 and in 1925 was appointed honorary adviser to the Army Industrial College.

COL. ROBERT P. LAMONT of New York, also a nominee for director, former Secretary of Commerce of the United States, was chief of the Procurement Division, Office of the Chief of Ordnance, during the World War. Born at Detroit, he was graduated from the University of Michigan, a bachelor of science in civil engineering, his first professional undertaking was with the Chicago Exposition. Later he served as an officer of the Simplex Railway Appliance Company, American Steel Foundries and Griffin Wheel Company. He was president of American Iron and Steel Institute, 1932-1933.

Commissioned a major in the Ordnance Department of the Army in February 1918, Colonel Lamont administered the huge procurement program of the Ordnance Department at Washington. He returned to civil life in February 1919, and resumed his connection with American Steel Foundries and other industrial organizations. He established the Astronomical Observatory of University of Michigan in South Africa.

COL. JAMES L. WALSH, consulting engineer of New York, N. Y., a nominee for director, is the founder of this journal. He is also a contributor to this issue (page 125). A native of Boston, Mass., he was graduated from the United States Military Academy a member of the class of 1909. Commissioned a second lieutenant of Coast Artillery, he was promoted through grades. In the World War he was an assistant to Maj. Gen. William Crozier and Maj. Gen. C. C. Williams, Chiefs of Ordnance.

Realizing the need for a strong informed group of engineers and industrialists who would foster the cause of industrial preparedness, Colonel Walsh served as first secretary of the Army Ordnance Association when it was organized in 1919. A year later he projected and edited the first issue of ARMY ORDNANCE and continued as editor until 1921 when he relinquished the office to become associated with Bankers Trust Company, New York. He was assistant vice-president of that institution and also a vice-president and director of McGraw-Hill Publishing Company. Later he became a vice-president of the National Bank of Detroit. He has served as a director and trustee of the Army Ordnance Association for many years. For his World War service he was awarded the Distinguished Service Medal.

MAJ. GEN. C. M. WESSON, Chief of Ordnance, recently announced the appointment of Horace B. Deal to be assistant chief of the St. Louis Ordnance District. Prominent in industrial and civic affairs of the St. Louis area, Mr. Deal will be an assistant to Col. Harry Scullin, district chief. Willard Cox is also an assistant chief of the district.

NEW MEMBERS

DURING the period June 1, 1940, to July 31, 1940, inclusive, the following applicants were admitted to membership in the Army Ordnance Association: P. Abe, Sidney, Ohio; Bernard B. Abrams, Terrell, Tex.; C. E. Adams, New York, N. Y.; T. H. Addie, Philadelphia, Pa.; Milton Ahlers, Dayton, Ohio; O. A. Ahlers, Dayton, Ohio; J. F. Alexander, Chattanooga, Tenn.; Fay Aller, Dayton, Ohio; K. J. Ammerman, Chicago, Ill.; Henry Anderson, New York, N. Y.; Maurice P. Anderson, Seattle, Wash.; T. A. Andrew, Glendale, Calif.; John A. Anthes, Long Beach, Calif.; L. Apple, Glen Ridge, N. J.; John F. Apsey, Jr., Towson, Md.; Gayle W. Arnold, Baltimore, Md.; Lyman C. Athy, Baltimore, Md.; Niles W. Atterbury, Pittsburgh, Pa.; K. W. Atwater, Pittsburgh, Pa.

H. F. Baldwin, New York, N. Y.; W. N. Barker, Chicago, Ill.; Philip S. Barnes, Rochester, N. Y.; Harry Barney, Pittsburgh, Pa.; E. R. Bauer, Toledo, Ohio; Charles G. Baumgartner, Pittsburgh, Pa.; Henry S. Beal, Worcester, Mass.; Peter M. Becker, Jr., Chicago, Ill.; Verne Beckmeyer, Binghamton, N. Y.; Edgar H. Bedell, Montclair, N. J.; Michael R. Belinky, New York, N. Y.; A. R. Belyea, Norwalk, Conn.; Raymond L. Benson, Baltimore, Md.; Thomas J. Bentivoglio, East Orange, N. J.; George P. Bentley, Wollaston, Mass.; Karl F. Berger, Bridgeport, Conn.; C. M. Bernegau, Hoboken, N. J.; Severin R. Beyma, Stanford University, Calif.; Daniel N. Black, Providence, R. I.; Ernest C. Blackard, Kingsport, Tenn.; E. W. Blanchard, Birmingham, Ala.; E. A. Block, New York, N. Y.; Howard E. Blood, Detroit, Mich.; W. W. Blunt, Scarsdale, N. Y.; F. H. Bonnet, Columbus, Ohio; Bradley H. Booth, Jackson, Ohio; F. E. Booth, Detroit, Mich.; George W. Borg, Chicago, Ill.; I. E. Boucher, Waltham, Mass.; H. H. Bound, Cleveland, Ohio; Earl H. Bradley, Providence, R. I.; H. T. Bradner, Cleveland, Ohio; J. A. Bradner, Cleveland, Ohio; Thomas C. Bright, Rome, N. Y.; E. H. Broden, Pittsburgh, Pa.; Carlton E. Brown, Cincinnati, Ohio; J. M. Brown, Cleveland, Ohio; Melville L. Brown, New York, N. Y.; Thomas F. Brown, Jr., Baltimore, Md.; W. Ellzey Brown, Cleveland, Ohio; Fred E. Brust, Philadelphia, Pa.; Grant M. Buchanan, Towson, Md.; Ray Butterfield, Napa County, Calif.

P. Calabro, Arlington, N. J.; Joseph O. Callouette, Akron, Ohio; C. C. Campbell, Harrison, N. J.; G. E. Campbell, Chattanooga, Tenn.; William J. Campbell, Indianapolis, Ind.; Victor Carbonara, Elmhurst, N. Y.; J. A. Carey, Plainfield, N. J.; Earle H. Carmany, Philadelphia, Pa.; Norman D. Carpenter, Pittsburgh, Pa.; John H. Carter, Towson, Md.; A. H. Case, Tampa, Fla.; P. E. Cate, Knoxville, Tenn.; Charles C. Chamberlain, New York, N. Y.; F. H. Chapin, Cleveland, Ohio; Marcus G. Christ, New Hyde Park, L. I., N. Y.; Gust J. Christenson, Chicago, Ill.; John Chrosniak, Chattanooga, Tenn.; Sidney I. Cole, Chicago, Ill.; C. I. Collins, Worcester, Mass.; Eugene F. Conroy, Steubenville, Ohio; M. D. Conroy, Granite City, Ill.; P. T. Coons, Cleveland, Ohio; Arthur B. Cooper, Washington, Pa.; Roy G. Cox, Philadelphia, Pa.; F. G. Cross, Knoxville, Tenn.

Richard G. Dame, Chicago, Ill.; H. E. Davies, Hasbrouck Heights, N. J.; L. L. Davies, Knoxville, Tenn.; Spencer E. Deal, Muncie, Ind.; Hubert O. De Beck, Burnsville, N. C.; Alonzo G. Decker, Jr., Towson, Md.; F. E. Deems, Birmingham, Ala.; Joseph R. Desch, Dayton, Ohio; J. Lindsay Dexter, Nashua, N. H.; Irving B. Dick, Glen Rock, N. J.; A. B. Dickerson, Washington, D. C.; C. F. Dierker, Columbus, Ohio; Myron B. Diggin, Matawan, N. J.; Herman L. Dillingham, New York, N. Y.; Adiel Y. Dodge, Rockford, Ill.; C. Michel Doiseau, Cincinnati, Ohio; Gommaine L. J. Domaige, Providence, R. I.; C. B. Dorgan, Cleveland, Ohio; A. E. Drissner, Cleveland, Ohio; John R. Dryden, Detroit, Mich.; F. C. Dull, Sidney, Ohio; F. C. Dumaine, Jr., Weston, Mass.; P. Dumaine, Waltham, Mass.

B. T. Eagerton, Cleveland, Ohio; Hugh H. Eby, Philadelphia, Pa.; Leopold Eckler, Binghamton, N. Y.; Alfred Ehrlich, Flushing, N. Y.; Daniel S. Elliott, Middle River, Md.; Charles G. Ellis, Enfield, Conn.; F. Winthrop Ely, Weston, Mass.; Edward D. Emerson, Trenton, N. J.; John L. Everhart, Linden, N. J.; William M. Ewart, Webster Groves, Mo.

John D. Falvey, University City, Mo.; William M. Farrer, Los Angeles, Calif.; David S. Faulkner, Torrance, Calif.; John H. Faunce, Jr., Middletown, Ohio; Robert J. Feuchter, Chicago, Ill.; J. T. Finley, Knoxville, Tenn.; E. E. Fisher, Denver, Colo.; William T. Fishpaw, Towson, Md.; E. A. Fitch, New York, N. Y.; M. B. Folsom, Rochester, N. Y.; John Forrest, Binghamton, N. Y.; James Forrestal, Binghamton, N. Y.; Elliott C. Foster, West Newton, Mass.; John M. Fox, Towson, Md.; R. M. Fox, Hammond, Ind.; Jasper H. Fritz, East Milton, Mass.; H. F. Fussner, Cleveland, Ohio.

J. V. Giesler, Knoxville, Tenn.; Frederick M. Gilbreth, Montclair, N. J.; Charles A. Glenn, Lynchburg, Va.; James B. Glover, III, Marietta, Ga.; John W. Glover, Marietta, Ga.; W. S. Going, Birmingham, Ala.; John J. Gordon, Jr., Watertown, Mass.; R. L. Gordon, New York, N. Y.; Alex J. Gossin, Rochester, N. Y.; L. H. Gould, Toledo, Ohio; J. M. Grady, Harrison, N. J.; A. Kenneth Graham, Philadelphia, Pa.; S. W. Gray, Flint, Mich.; Charles C. Green, New York, N. Y.; W. Russell Greer, Baltimore, Md.; Foster M. Gruber, Los Angeles, Calif.; W. G. Gruening, Verona, N. J.; Walter A. Gueffroy, San Carlos, Calif.; W. S. Guitteau, Cincinnati, Ohio; F. M. Gunn, Chicago, Ill.; C. Gunther, Rutherford, N. J.; H. F. Gurney, New York, N. Y.

C. E. Hagler, Birmingham, Ala.; Norman W. Halls, St. Louis, Mo.; R. L. Hamill, New York, N. Y.; J. L. Hamilton, Jr., Granite City, Ill.; William E. Hamilton, New York, N. Y.; H. H. Hampton, Cleveland, Ohio; William B. Hannum, Jr., Jamaica, L. I., N. Y.; M. R. Hansen, Columbus, Ohio; Francis A. Harding, Dedham, Mass.; Richard Hartshorne, II, East Orange, N. J.; Ethan R. Haslage, Los Angeles, Calif.; Adolph F. Haverkamp, Fort Thomas, Ky.; J. L. Haynes, Chicago, Ill.; Nicholas W. Hayson, Pittsburgh, Pa.; F. Hazen, Palisades Park, N. J.; T. Lyle Hazlett, Pittsburgh, Pa.; Richard A. Heald, Worcester, Mass.; Roger N. Heald, Worcester, Mass.;

Ernest B. Heavilon, Parma, Ohio; F. H. Heidtman, Toledo, Ohio; W. W. Heimberger, Columbus, Ohio; C. M. Heller, Toledo, Ohio; W. G. Helsel, Butler, Pa.; A. E. Henn, Cleveland, Ohio; M. W. Henry, Knoxville, Tenn.; W. M. Hepburn, Toledo, Ohio; W. F. Herdrich, Detroit, Mich.; D. C. Herricks, Birmingham, Ala.; H. M. Heyn, Toledo, Ohio; Henry H. High, Wyncote, Pa.; F. Leroy Hill, Garden City, N. Y.; R. M. Hodge, Knoxville, Tenn.; Raymond Hoffman, Hamilton, Ohio; A. L. Hollinger, Toledo, Ohio; Frederick Holmes, Lafayette, Ind.; C. F. Hood, Cleveland, Ohio; J. H. Hornung, Yonkers, N. Y.; Clifton P. Howard, Worcester, Mass.; Ward C. Howard, Jerome, Idaho; Harry E. Howland, Ithaca, N. Y.; A. J. Hoyt, Cleveland, Ohio; C. J. Hudson, Toledo, Ohio; Victor C. Huffsmith, March Field, Calif.; Frank E. Humberger, Cincinnati, Ohio; Frederick W. Huth, Baltimore, Md.

W. L. Iliff, Harrison, N. J.; Harold G. Ingersoll, New Castle, Pa.; R. C. Ingersoll, Chicago, Ill.; Carl R. Jack, Birmingham, Ala.; Harold A. Jahraus, Cincinnati, Ohio; Walter E. Jervey, Jr., Marietta, Ga.; Thomas L. Jenner, West Hartford, Conn.; C. J. Jesnig, Delaware County, Pa.; Curt G. Joa, Sheboygan Falls, Wis.; George T. Johnson, Columbus, Ohio; H. Stanley Johnson, Jr., Madison, Wis.; Norman B. Johnson, Chicago, Ill.; Ray P. Johnson, Chicago, Ill.; B. B. Johnston, Granite City, Ill.; S. P. Jonas, Parma, Ohio; F. S. Jones, Denver, Colo.; Fiske R. Jones, Fitchburg, Mass.; John P. Jones, Chester, Pa.; H. B. Jordan, Cleveland, Ohio.

Kenneth Kauffman, Wauwatosa, Wis.; E. Adolf Keller, Dayton, Ohio; K. Keller, Hoboken, N. J.; R. D. Kelley, Toledo, Ohio; F. A. Kelly, Cleveland, Ohio; J. F. Kelly, Rochester, N. Y.; John W. Kelly, Frankfort, Ky.; C. J. Kenerson, Ithaca, N. Y.; Alex J. Kent, Murphysboro, Ill.; A. R. Kerr, Pittsburgh, Pa.; A. W. Keuffel, Hoboken, N. J.; W. G. Keuffel, Hoboken, N. J.; W. L. E. Keuffel, Hoboken, N. J.; Ralph T. King, Cleveland Heights, Ohio; R. C. Kinley, Cleveland, Ohio; Marvin M. Klein, Rochester, N. Y.; H. J. Knerr, Annapolis, Md.; Paul Knowles, Elmhurst, N. Y.; Paul Kollsman, Elmhurst, N. Y.; R. S. Komarnitsky, Verona, N. J.; Raymond Koontz, Greenwich, Conn.; John H. Krafft, Chicago, Ill.; H. W. Kranz, Cleveland, Ohio.

Tom A. Lamke, Waterloo, Iowa; Edward J. Lange, Long Beach, Calif.; Sears Lehmann, Jr., St. Louis, Mo.; H. J. Leisenheimer, Cleveland, Ohio; David Levin, Philadelphia, Pa.; T. R. Lichtenwalter, Canton, Ohio; William J. Liddell, Los Angeles, Calif.; C. A. Liddle, Chicago, Ill.; Leon J. Lieberman, Conshohocken, Pa.; Ralph A. Lind, New York, N. Y.; Howard Livezey, Greensburg, Pa.; Clyde Llewelyn, New Britain, Conn.; Russell R. Lord, Alton, Ill.; T. F. Loughry, New York, N. Y.; Arthur Lundeen, New York, N. Y.

A. J. MacDonald, Chicago, Ill.; R. Y. MacIntyre, Birmingham, Ala.; William E. Mackintosh, San Francisco, Calif.; Robert L. Madden, New York, N. Y.; F. W. Magin, Detroit, Mich.; Percy C. Magnus, New York, N. Y.; Cecil Mann, West Newton, Mass.; Irving E. Mansback, Easton, Pa.; G. D. Mantle, Pittsburgh, Pa.; William M. Marks, Whittier, Calif.; Fred H. Markwick, Dayton, Ohio; F. J. Marshall, New York, N. Y.; William G. Marshall, Pittsburgh, Pa.; Harry E. Martin, Detroit, Mich.; O. L. Martin, Chattanooga, Tenn.; Thomas B. Martin, Elmira, N. Y.; Wendell L. Martin, Cleveland, Ohio; Silas T. Massey, Worcester, Mass.; W. W. Matchneer, Columbus, Ohio; J. Walter Materne, Philadelphia, Pa.; John May, Cleveland, Ohio; A. J. McComb, New York, N. Y.; Joseph P. McConnon, New York, N. Y.; William A. McCree, Jr., Orlando, Fla.; A. J. McDuff, Bass River, Mass.; J. McElgin, Philadelphia, Pa.; W. J. McKee, Worcester, Mass.; W. Kenneth McKnight, Pittsburgh, Pa.; Henry C. McLean, Columbus, Ohio; James E. McLean, Pittsburgh, Pa.; Frank R. Mead, New York, N. Y.; H. P. Mee, Cleveland, Ohio; Gunther Meier, University City, Mo.; H. O. K. Meister, Harrison, N. J.; A. F. Mellman, Cleveland, Ohio; William Menoher, Aberdeen, Md.; Lauron W. Mercer, Detroit, Mich.; C. A. Mescher, Chicago, Ill.; C. P. Millard, Harrison, N. J.; M. D. V. Millard, Washington, D. C.; Howard L. Miller, Canton, Ohio; Macon P. Miller, Radford, Va.; W. D. Miller, Knoxville, Tenn.; F. W. Moffett, Rochester, N. Y.; J. Molner, Cleveland, Ohio; Robert D. Moore, Wilmington, Del.; T. H. Morcom, Rochester, N. Y.; Jack B. Morehouse, Columbus, Ohio; Henry Morgan, Detroit, Mich.; David Morris, New York, N. Y.; Harold S. Morton, Minneapolis, Minn.; Robert E. Moyer, Jr., Allentown, Pa.; D. S. Muckley, Pueblo, Colo.; H. L. Mueller, Cleveland, Ohio; Preston H. Mulcahy, San Francisco, Calif.; James H. Myers, Cincinnati, Ohio.

Charles M. Neidelman, Jefferson City, Tenn.; Louis B. Nelson, Baltimore, Md.; F. D. Newbury, East Pittsburgh, Pa.; C. L. Newby, Chicago, Ill.

William F. Ocenasek, Plainfield, N. J.; Clinton G. Ofield, Flint, Mich.; E. P. O'Neill, Drexel Hill, Pa.; R. W. Oswald, Philadelphia, Pa.; O. Otterson, Butler, Pa.; W. O. Owen, Chicago, Ill.

Erik G. Paech, Los Angeles, Calif.; Warren R. Palmer, Norwalk, Conn.; R. H. Parks, East Rochester, N. Y.; Willett H. Parr, Jr., Lebanon, Ind; S. Sherwood Parsons, Cleveland, Ohio; Joseph H. Pengilly, Los Angeles, Calif.; Isaac P. Perkins, Arlington, Va.; J. A. Perry, River Forest, Ill.; L. A. Petersen, New York, N. Y.; Mason Phelps, Chicago, Ill.; Raymond W. Phelps, Rutherford, N. J.; C. B. Phillips, Toledo, Ohio; William P. Phillips, Louisville, Ky.; W. P. Pickhardt, New York, N. Y.; G. S. Pierce, Columbus, Ohio; L. L. Pollak, Montclair, N. J.; Albert Poock, Dayton, Ohio; S. H. Potter, Pueblo, Colo.; A. L. Powell, Prattville, Ala.; Paul Quay, Cleveland, Ohio; L. F. Quigg, Pueblo, Colo.

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NECROLOGY

COL. BENJAMIN A. FRANKLIN, chief of the Hartford Ordnance District since 1922, died at Springfield, Mass., June 17, 1940. His death came as a distinct shock not only to his many friends and admirers in New England but also to his associates in the Army Ordnance Association of which he was a charter member and to which he had rendered exceptional service. In only the last issue of this journal an account was published of the meeting of the Hartford Ordnance District, May 10, 1940, at which Colonel Franklin presided. Never before in the history of the district had a more successful meeting been held. The district is noted for its aggressive organization and the fine caliber of its coöperation in the defense program. Much of this spirit is attributable to the leadership of Colonel Franklin whose labors to further the Ordnance cause in New England were unremitting.

Colonel Franklin was born in Northumberland County, Va., October 15, 1869. He received his schooling in Baltimore at the Johns Hopkins University. He began his business career as an employee of the Midvale Steel Company of Pennsylvania, and, after thirteen years, went to Boston as general manager of the United States Steel Company.

In 1909, Colonel Franklin joined the Strathmore Paper Company, West Springfield, and remained there until his resignation as vice-president in 1932. Since that time he had been an industrial engineer and business counselor, and was identified with many companies in the paper industry.

In these pages within the past year a notice was published of Colonel Franklin's last book—an inspirational study entitled "Banners in the Wind." In it he expressed a personal philosophy well known to his many friends. In mourning his death those friends can take consolation from the fine example of this philosopher-industrialist-patriot. His service to the national defense was of the very highest!

BRIG. GEN. JOHN T. THOMPSON, U. S. Army, Retired, died June 21, 1940, at his home, Great Neck, Long Island, New York. Among the Ordnance fraternity he will be remembered for his pioneering work in war planning prior to the World War and for his exceptional service during that conflict. Among a larger group his name will be associated with the Thompson submachine gun.

General Thompson was born in Newport, Ky., December 31, 1860. He was graduated from the United States Military Academy in 1882 and commissioned a second lieutenant of Artillery. He transferred to the Ordnance Department in December 1890.

In the Spanish-American War General Thompson served in the rank of lieutenant colonel, and during this period of his service from July to October 1898, he was Chief Ordnance Officer, Fourth Army Corps. Then he was a member of the Board of Officers to select camp sites in Cuba and was charged with arrangements for Ordnance Depots on the island to November 1898, and later served in the office of the Chief of Ordnance.

From February 1904 to October 1907, General Thompson served as assistant to the commanding officer, Rock Island Arsenal. Then followed a detail in Washington, D. C., as senior assistant to the Chief of Ordnance.

General Thompson retired November 2, 1914. He was recalled to active service in the Ordnance Department April 16, 1917, and was chief of the Small Arms Division, Ordnance Office, and in charge of design and manufacture of small arms and cartridges. He served as advisory engineer, Director of Ordnance Training, Director of Arsenals, to December 20, 1918. On June 31, 1930, General Thompson was promoted to brigadier general, retired. He was awarded the Distinguished Service Medal for his World War service.

OTTO W. BUENTING, a vice-president of the Pittsburgh Post, Army Ordnance Association, and vice-president of the Westinghouse Air Brake Company and of the Union Switch & Signal Company, died at Lewes, Del., July 27, 1940. Mr. Buenting, who was a past president of the National Association of Manufacturers, had been continuously associated with the Westinghouse Air Brake Company since 1901, following his graduation from Purdue University.

He was a director of the First National Bank of Wilmerding, the First National Bank of Swissvale, and the Swissvale Trust Company. Other affiliations included thirty-five years of service as a director and trustee of the Young Men's Christian Association of Wilmerding.

Mr. Buenting was a charter member of the Army Ordnance Association and a past president of the Pittsburgh Post. He had taken an active interest in the affairs of the society since its foundation. The national Association shares with the Pittsburgh Post the loss of a gentleman who had aided materially in the advancement of ordnance progress in the United States.

NOTICE has been received of the death of the following members of the Association: Walter C. Doering, St. Louis, Mo.; William Horlick, Jr., Racine, Wis.; W. G. Robinson, Albany, N. Y.; W. S. Rugg, Pittsburgh, Pa.; E. W. Slocum, Detroit, Mich.; W. E. Wilkinson, York, Pa. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

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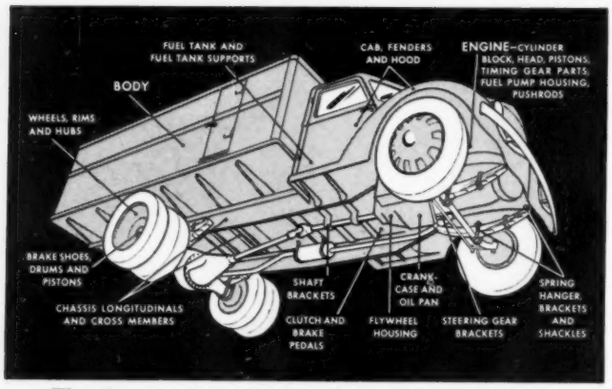
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From the Record

The following quotations are from addresses or writings of recognized authorities and comprise a cross section of opinion on subjects closely allied to the national defense. They have been selected for publication as being important and timely. ARMY ORDNANCE *thus hopes to acquaint readers with qualified views regarding various phases of industrial preparedness.*

TO GIVE SOME IDEA OF THE ENGINEERING PREParation involved in tank construction, it should be noted that approximately 2,400 individual drawings are required in the complete design of the light tanks. The 155-mm. gun carriage requires approximately 1,000 separate drawings and an additional 500 for the recoil mechanism. Even the tank guns of 75 mm. require 300 drawings and their panoramic sight, 160. This is merely to suggest the energy and time necessary before these instruments can begin to roll off a production line. . . . There is scarcely a defense instrument which does not depend for its production upon the machine-tool industry. This industry was the first and most important potential bottle neck which this department confronted. It was considered immediately, and steps were taken to work out a prompt solution. Through the unlimited coöperation of the industry, which set up its own defense committee, I am able to report that the huge planers and millers needed to work armor plate, particularly for the expanded naval program, will be available on time, according to reports to me from the industry. This should prevent what might have been a serious delay in naval construction. It also can be said that the machine-tool builders are making their facilities available to the defense program on a voluntary basis as completely and effectively as though war-time priorities were in effect.—*William S. Knudsen, chief of industrial production, National Defense Advisory Commission, Washington, D. C.*

SURVEYS AND STUDIES MADE BY THE MATERIALS division of the National Defense Advisory Commission offer reliable indications that we may expect to have available adequate supplies of critical and strategic materials as needed by defense industries. Obtaining extraordinary supplies of some naturally will require greater effort and perhaps more ingenuity than others. The situation generally, however, is more hopeful than we anticipated six weeks ago when this Commission was appointed by the President. It should be said at this point that the generous coöperation which we have received from the many departments of the Government called upon to assist us has expedited our preliminary tasks immeasurably. We also have had a most gratifying response from industry which is making available to us vital and most confidential information from mines, mills, factories, and research laboratories as well. When this Commission was appointed, it was felt that the problem of adequate rubber supplies was one of the most pressing. For this vital raw material we have been dependent primarily upon the Malay Peninsula and the East Indies. Several weeks ago, the President suggested a study of synthetic-rubber production. As a result we have conferred with each of the companies owning or controlling synthetic-rubber processes. Several have been developed beyond the experimental stage to a point where plans for individual producing units are being engineered. It is expected that before this month is over a plan of synthetic-rubber production will have been worked out which in the future could eliminate our dependence upon imports.—*Edward R. Stettinius, Jr., chief of the materials division, National Defense Advisory Commission, Washington, D. C.*

Professional Digest

The following items of current information and opinion aim to present a wide range of facts and discussion relating to recent developments of professional military interest. Quotation marks are frequently omitted but sources are indicated.

THE MOST FAR-REACHING CHANGE IN ARMY organization since the World War is the recent separation from the Infantry and Cavalry of their tank and mechanized elements and incorporation of them into an armored corps of two divisions. Besides the importance of this creation of an armored field force as a fighting unit is the significance of the fact that responsibility for the maintenance, training, and development of all tanks and mechanization has been withdrawn from the Chiefs of Infantry and Cavalry and placed under the direction of the newly appointed Armored Field Force commander, Brig. Gen. Adna R. Chaffee, formerly commander of the 7th Cavalry Brigade (Mechanized). Thus, for the time being at least, the development of armored fighters is an independent field function reporting directly to the Chief of Staff. While the new Armored Field Force will be neither Infantry nor Cavalry, the personnel, for the present, will retain their identity as individual Infantry and Cavalry officers and enlisted men. According to the *Army and Navy Journal*, there is strong possibility, however, that the development will lead to a new branch or arm probably to be known as the Armored Corps. As tentatively decided upon, the armored divisions will have 272 light tanks, 110 medium tanks, and 201 scout cars. These "tanks" will include the vehicles formerly designated as "combat cars"—a term which is now abolished.

THE PRESENT TANK STRENGTH OF THE NEW Armored Field Force consists of approximately 400 vehicles of all ages and types. From the Infantry have been taken the M2A1, M2A2, M2A3, and M2A4 light tanks and the M2 and M2A1 medium tanks, as well as a few T-4's. From the Cavalry has come the combat car, similar to the M2A1. It is interesting to note that the trend is constantly toward greater weight. The M2A1 light tank, first built in 1935, weighs about 10 tons; the M2A4 is about 12 tons. The M2 medium tank weighs about 17½ tons; the M2A1 medium tank, about 19 tons. Current production is concentrated at this time on the M2A4 light tank, both diesel- and gasoline-driven. Deliveries are now being made of some of the 329 light tanks ordered about six months ago from American Car and Foundry Company, and an additional order for 667 tanks recently was placed with the same company. Rock Island Arsenal, which also produces tanks, has speeded up its output considerably, but to put a second private producer in the field, an educational order has been placed with Baldwin Locomotive Works of $587,694.40 for light tanks and related items.

TO COÖRDINATE ALL TROOP TRAINING, THE nucleus of a General Headquarters has been created and located at the Army War College, Washington, D. C., with Brig. Gen. Lesley J. McNair, as chief of staff. To relieve Deputy Chief of Staff William Bryden of some of the mass of detail falling upon him as executive officer to Gen. George C. Marshall, Chief of Staff, Brig. Gen. Richard C. Moore, Assistant Chief of Staff, G-4 (Supply), has been made an additional Deputy Chief of Staff to handle all matters pertaining to supply and construction and all matters pertaining to the Air Corps and the Armored Force, except training and personnel. Thus, the move has a two-fold significance. First, with large bodies of recruits—and later probably draftees—coming into the Army to be trained, a co-

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ordinated training authority was needed. The second step is a preparedness move. In any emergency, should troops be placed in the field, a commander would have to be named and his staff chosen. Army Regulations provide that the Chief of Staff shall function as that commander of field forces until relieved. Now, however, there will be a nucleus of a staff for that commander, with General McNair directing the activities of some seven or eight officers as yet unnamed. General Marshall will function in the dual rôle of commander of the field forces directing activities of the GHQ and as Chief of the War Department General Staff.

THE PRESENT ARMAMENT PROGRAM, ACCORDING to General Marshall, Chief of Staff, calls for a force of 2,000,000 men, to be organized into 45 divisions of infantry and 10 armored divisions. Eight more tank divisions will be organized as soon as equipment becomes available. By January 1st, General Marshall predicted, the Army will have 16 divisions in active service and completely equipped. The four National Guard divisions, which will be called to service as soon as congressional authority is given, will be completely equipped by the first of the year. He said that the National Guard should have a minimum of four weeks' training in camp before the compulsory military training becomes effective about September 1st. With respect to matériel, 6 of the Regular Army divisions have modern equipment, and 18 of the National Guard divisions have about 50 per cent of modern equipment. The Army has a fair amount of tanks at the present time, and additional tank deliveries are coming in.

THE NEW 90-MM. ANTIAIRCRAFT GUN IS NOW A standard antiaircraft weapon for the Coast Artillery. Its rôle will be essentially that of the present standard 3-inch antiaircraft gun, M2A2, which it will replace in so far as future procurement is concerned. However, all serviceable 3-inch antiaircraft guns, including those now under manufacture, still are classed as standard and are to be continued in service. For the present, technical details of the new weapon will remain in a restricted category. According to the *Coast Artillery Journal*, the gun will be known as the 90-mm. antiaircraft gun, M1, on 90-mm. antiaircraft mount, M1. Although its developed rate of fire probably will be slightly less than that of the 3-inch, its projectile is considerably heavier; hence in over-all effectiveness—number of effective fragments per unit of time—the 90-mm. represents a considerable improvement over the standard 3-inch weapon. The projectile of the new gun also has a shorter time of flight than that of the 3-inch for corresponding ranges and consequently a greater maximum useful range. In over-all weight and in tactical mobility the two weapons are approximately equal. The 90-mm. mount is of the single-axle, dual-wheel type. Thus the weight per wheel is no greater than in the case of the 3-inch. On-carriage fire-control equipment is of the conventional type. The bogie is equipped with electric brakes.

A WAR DEPARTMENT CONTRACT HAS BEEN signed with E. I. du Pont de Nemours & Company, for the construction of a $25,000,000 powder plant at Charlestown, Ind. It will have a production capacity of 200,000 pounds a day. The present national capacity is less than 30,000,000 pounds per year.

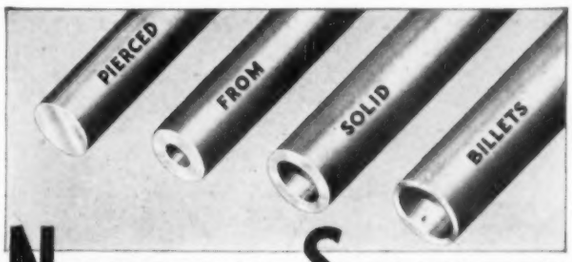
THE WHITE MOTOR COMPANY HAS BEEN awarded a $5,400,000 contract for scout cars which will go to the Armored Field Force and to the new reconnaissance units of the triangular divisions. No vehicles of the combat-car type are being ordered at this time. The medium tank's design has been restudied as a result of German operations in Belgium and France, and the new designs are about ready for test. Orders should be placed soon for this type. The heavy tank is still on the drawing boards. Here the problem is not so much that of production, for heavy tanks were built during the World War, but the question of the size best suited for tactical use must be

answered, together with problems of safe bridge loads, highway capacities, and the like. The new light tanks on order will be armed, in addition to machine guns, with 37-mm. cannon, and the larger tanks under study may carry guns of even larger caliber. A few diesel-propelled tanks are included in the orders. Diesel-driven tanks and scout cars were tested at the recent Third Army maneuvers and more of them are to be put into use.

A COMPLETE SET OF PACK ACCESSORIES FOR THE 60-mm. mortar and ammunition has been manufactured by the Ordnance Department and sent to the Cavalry Board for final test. One pack horse carries the mortar, spare parts, tool roll, and eighteen rounds of ammunition. The ammunition pack horse carries thirty rounds of ammunition. Ammunition is carried in fiber shipping containers, which simplifies supply and holds weight to a minimum. The Cavalry Board recently conducted a test of a 20-mm. Solothurn antitank gun to determine the feasibility of packing the gun and mounting it in combat vehicles as a possible replacement for the caliber .50 machine gun. This gun is mounted either on a light, portable wheeled mount or on a bipod and butt rest. When in firing position on the bipod and butt rest, the gun weighs about 119 pounds without magazine or cartridges. It is a recoil-operated, autoloading weapon.

THE TWO HORSE AND MECHANIZED HORSE Cavalry regiments recently organized by the Army will be composed of a headquarters and headquarters troop, a service troop, a horse-squadron portée, and a mechanized squadron. Each regiment will have 451 horses. The tremendous fire power of these two new units is seen in the armament which will include 48 light machine guns, 136 heavy machine guns, 78 caliber .50 machine guns, 208 submachine guns, 6 37-mm. antitank guns, 1,114 pistols, and 499 rifles. The mechanized equipment of each regiment will consist of 68 scout cars, 80 solo motorcycles, 60 motorcyles, 14 command-reconnaissance ½-ton trucks, 39 cargo 2½-ton trucks, and 55 truck-tractors with semitrailers.

WHEN THE PRESENT PROGRAMS APPROPRIATED for and authorized are completed, the Navy's combatant ship tonnage will have increased from its present 1,236,140 tons to nearly 3,200,000 tons; the number of airplanes will have increased from the present 1,800 to an authorized 15,000; the service personnel will have jumped from the present 136,949 men and 10,418 officers to 170,000 men, and many additional officers. A total of $187,132,000 will have been spent on aviation bases, and navy yards and shore bases will have been greatly expanded, according to the *Army and Navy Journal*. The present 1,236,140 tons of combatant vessels are divided among 15 battleships, 5 aircraft carriers, 18 heavy cruisers, 19 light cruisers, 182 destroyers, and 95 submarines. There are under construction under former appropriations 8 additional battleships, 2 aircraft carriers, 6 light cruisers, 38 destroyers, and 19 submarines, plus auxiliaries. Twenty-four ships are provided for in the regular 1941 budget. Orders for 2 battleships, 1 aircraft carrier, 2 light cruisers, 8 destroyers, 6 submarines, 3 auxiliaries, and a large seaplane tender have been placed. The authorized 11 per cent expansion of the Navy carries about $750,000,000 for 68 combatant ships and 29 auxiliaries—a total of 97 vessels. Out of these funds also comes money to expand shipbuilding facilities. These vessels were ordered from navy yards, and negotiated contracts were placed for the remainder shortly after the President signed enabling legislation. Included in the order were 3 aircraft carriers, 4 heavy cruisers, 9 light cruisers, 30 destroyers, 22 submarines and the 29 auxiliaries. Completion of these programs will give the Navy 1,861,180 tons of combat ships. In addition, a 70 per cent expansion of the Navy requested by Adm. Harold R. Stark and approved by Congress will add 385,000 tons of capital ships, 200,000 tons of carriers, 420,000 tons of cruisers, 250,000 tons of destroyers, and 70,000 tons of submarines—a total of 1,325,000



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tons, which will bring total Navy combat tonnage to 3,186,180. Although the Navy has not released figures on the actual number of vessels to be built under the 70 per cent expansion, the line-up will probably be about as follows: 9 battleships, 5 carriers, 24 cruisers, 122 destroyers, and 40 submarines.

BETWEEN 30,000 AND 40,000 ENROLLEES ALREADY are taking training in manual occupations of service to national-defense industries, according to the National Defense Advisory Commission. The training program, sponsored by the Defense Commission through the office of Sidney Hillman, member of the Commission in charge of labor supply, is operated through a WPA project with the United States Office of Education as cosponsor. The primary purpose of training is to make available opportunities for those on WPA rolls to take refresher courses and thereby retrieve their earlier skill. It also provides those in industry with opportunities to improve their skill. It is not intended to serve as a substitute for existing apprenticeship training facilities. Fifty thousand enrollees will be taken directly from WPA rolls. The balance will be selected through state employment services coöperating with the United States Employment Service and from among workers already employed in industry who wish to improve their skill.

A CHANGE IN THE ASSIGNMENTS OF SEVERAL colonels of the Ordnance Department in the Office of the Chief of Ordnance heads a number of changes among officers who have been assigned to duty in that office. Col. Richard H. Somers, formerly Secretary of the Army Ordnance Association and editor of this journal, has been transferred from duty as commanding officer of Watervliet Arsenal, Watervliet, N. Y., and has been assigned to duty as chief of Technical Staff in the Office of the Chief of Ordnance. He replaces, in that capacity, Col. G. M. Barnes who has become assistant to Brig. Gen. Charles T. Harris, Jr., chief of Industrial Service in the Ordnance Office. Colonel Barnes is a special assistant for engineering. Col. A. G. Gillespie, recently on duty in the Ordnance Office as chief of the Artillery Division, Industrial Service, has succeeded Colonel Somers as commanding officer of Watervliet Arsenal. Col. Burton O. Lewis, recently on duty at Aberdeen Proving Ground, Md., has been assigned to Industrial Service in the Office of the Chief of Ordnance as assistant to General Harris in charge of production. Lieut. Col. L. H. Campbell, formerly in charge of artillery ammunition production at Frankford Arsenal, is now on duty in Washington as an assistant to the Chief of the Industrial Service in charge of new plant facilities.

THE DYNAMOMETER BUILDING OF THE NEW Power Plant Laboratory at Wright Field, Ohio, will consist of one story with basement and, with a connecting corridor to the present building, will cover an area of about 30,000 square feet, according to the *Army and Navy Journal*. Two test rooms with adjoining soundproof control rooms will be provided for testing both liquid-cooled and air-cooled engines developing 8,000 horsepower from sea level up to 15,000 feet altitude, and 4,400 horsepower at 30,000 feet altitude. The dynamometers are designed for testing any shape of engine and form of drive, including counter-rotating concentric propeller shafts. This building also will contain three large laboratories designed respectively for testing turbo superchargers, carburetors, and aircraft heat exchangers under simulated altitude conditions. The basement of the building will contain blowers, exhausters, refrigeration equipment, pumps, etc., requiring about 12,000 horsepower in electric motors. To house the additional switchboards for controlling this electric power, a 53 by 68-foot extension has been added to the south end of the present building. A water-cooling tower will be erected over the present cooling pond. The east extension to the torque-stand building will provide four engine rooms.

Ordnance Reserve

UNDER the provisions of Public No. 611, 76th Congress, the President has authorized the calling of Ordnance Reserve officers or Specialist Reserve officers assigned to the Ordnance Department to extended active duty for such periods as may be necessary to carry out the provisions of this act. Under this act, Reserve officers will be ordered to duty until June 30, 1941. It is anticipated that if the need continues to exist, the appropriation for the fiscal year 1942 will authorize an extension of one year, and officers whose services are satisfactory will be continued on duty for that period of time.

It is the policy of the Chief of Ordnance to call to duty only captains and lieutenants. Officers of higher rank will not be called except to fill vacancies for which qualified captains or lieutenants are not available.

Officers ordered to extended active duty are authorized eight cents per mile for travel. Baggage and freight allowances are appropriate to their grade. No allowance is made for travel of their dependents to their first station.

To assist in procuring the necessary number of qualified officers in the company grades for duty in connection with production, inspection, and proof work, the transfer of Reserve officers of other arms and services to the Ordnance Department Reserve for extended active duty has been authorized, provided they request such transfer, are recommended by the Chief of Ordnance for the transfer and for extended active duty, are physically qualified for such duty, and provided the chief of arm or service from which transfer is sought recommends favorably. The following qualifications are considered essential: the Reservists (1) must be in the grade of captain or lieutenant (no reduction in grade will be made for this duty); (2) graduates of a college or university; (3) during the past five years, or for a lesser period if graduated subsequent to 1935, must have been actively engaged in a pursuit which in the opinion of the Chief of Ordnance qualifies them for the positions for which they are desired. This includes practical production, engineering, research and other duties similar to the production, inspection, storage, and maintenance of ordnance.

War Department Circular No. 89, November 10, 1939, amends AR 140-5 by adding paragraph 26½, as follows:

"26½. Qualification for reappointment by reason of extended active duty with the Regular Army.—Any Reserve officer who fails to meet the requirements of paragraph *26a* for reappointment, while on extended active duty in excess of 30 days with units or installations of the Regular Army, may be recommended for reappointment with full eligibility for assignment, active duty, or promotion, by the officer with assignment jurisdiction. Such recommendations will not be made unless accompanied by a report showing that the officer concerned has been rated as at least "satisfactory" while on such duty. If approved, The Adjutant General will reappoint the officer with full eligibility. Approval will not be withheld solely by reason of the officer's failure to meet the requirements of paragraph *26a* (3)."

Revised AR 140-5, effective October 1, 1940, provides that subsequent to June 30, 1940: (1) All Reserve officers who complete not less than six months continuous service with the Regular Army will be exempted from the practical test required for a certificate of capacity for promotion; (2) Exemptions under the Army extension-course requirements will be determined in each case by the War Department based upon the duties performed and the training received; (3) Reserve second lieutenants completing not less than 1½ years of continuous service with the Regular Army will be exempted from all requirements

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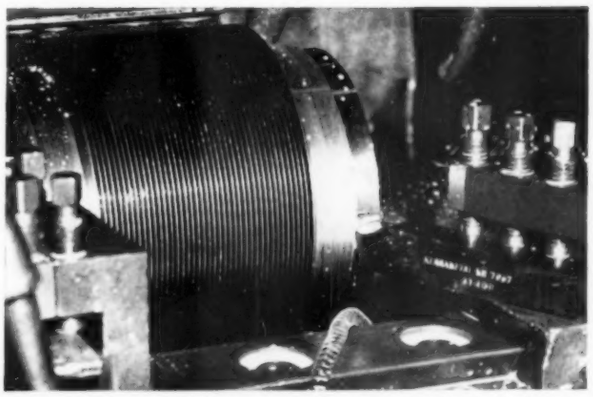

Turning Nitralloy steel cylinder barrels for airplane engines. Hardness of material, 230-240 Brinell; speed, 200 ft. per min.; feed, .006". Only one of the four KENNAMETAL tools used in this operation is illustrated.

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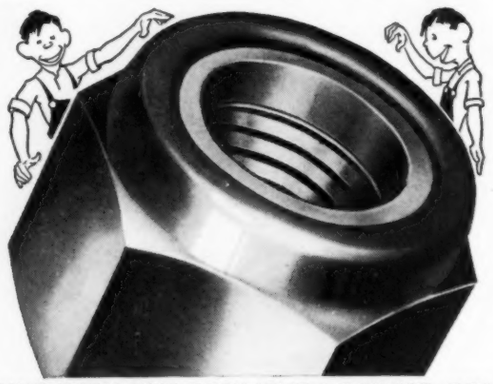

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for a certificate of capacity for promotion. These revised regulations make no distinction between Reserve officers on duty under the Thomason Act, as amended, and those serving under Section *37a,* National Defense Act, or other acts.

THE schedule of summer training camps for officers of the Arm and Service Assignment Group has been changed considerably since its publication. The removal of the Ordnance Field Service School from Raritan Arsenal to Aberdeen Proving Ground necessitated cancellation of the Raritan camps. The added load at Aberdeen precluded all Reserve training at that station except the staff-and-logistics course. While the camps scheduled for Rock Island Arsenal, Watertown Arsenal, Watervliet Arsenal and the University of Michigan were conducted as planned, the facilities at those stations were limited and the quotas were quickly filled. For this reason, the majority of summer trainees received individual training at the stations to which they were assigned.

Army Regulation No. 140-39, dated July 24, 1933, which applies to officers of the Specialist Reserve, is still in effect almost without change. The regulations are brief and definite in so far as the requirements for officers of this section are prescribed. Certain specific subjects are listed as mandatory. Although the Ordnance Office has made every effort to insure that all officers of the Specialist Reserve assigned to duty with the Ordnance Department were advised of the requirements, the records indicate there are still a number of those officers who have not completed the mandatory work. In some instances it was found that the officers were not aware of the requirements.

Paragraphs 4 c and d of those regulations read as follows:

"c. All Specialist Reserve officers subsequent to their appointment will be required to be qualified in the following subjects unless specially excepted by the Secretary of War: (1) Military discipline, courtesies, and customs of the service; (2) Commercial law—contracts; (3) Organization of the supply arm and service to which assigned; (4) Industrial mobilization; (5) Additional courses.—Additional courses may be prescribed by the chiefs of the supply arms or services to which specialists are assigned.

"d. These subjects, except those under c(5) above, should be completed during the first two years of service. In exceptional cases, this period may be extended by the chief of the supply arm and service, provided that all subjects will be completed during the period of the current appointment."

Attention of all Reserve officers is called to paragraph 118*a*, AR 140-5, which provides that prompt notification on W.D., A.G.O. Form No. 172 (Personal Report of Reserve Officer) of a permanent or prolonged temporary change of address will be made to The Adjutant General through military channels. In cases of a short temporary change of address, the necessary arrangements should be made to have forwarded any orders or communications received at the permanent address. Much delay and confusion have resulted from failure to comply with this paragraph.

H. E. A.

"NOTES ON U. S. ORDNANCE"

Volume I: "SMALL ARMS, 1776-1940"
By Capt. James E. Hicks
Mount Vernon, N. Y.
Illustrations by André Jandot
(Reviewed on page 154)

For sale by the author $4.50 postpaid

Ordnance in Review

RECENT DEVELOPMENTS IN SPORTING ARMS, PART V

BY LIEUT. COL. CALVIN GODDARD, ORD. RES.

ON March 28, 1907, there convened at Springfield Armory, Mass., a board of officers "for the purpose of testing such revolvers and automatic pistols as may be referred to the board by the Chief of Ordnance." It soon rendered a report which ultimately led to the adoption of the Colt automatic pistol, caliber .45, Model 1911, as the standard side arm of the military and naval forces of the United States. Today this weapon continues to serve these forces stoutly and efficiently—no serious contender for the honor having thus far appeared.

But the sample which was presented to the board in question bore only general resemblance to the model adopted four years later. Many were the modifications and improvements which it underwent in the interim. And though the Model 1911 has been continued through three decades without significant alteration, it would have required one gifted with unusual powers of divination to foretell the countless appliances (multishot magazines, extension stocks, overlong barrels, etc., etc.) which have been devised for attachment to it.

Most significant among these, however, have been sundry gadgets intended to make possible subcaliber practice with this weapon. Quite naturally, the caliber chosen has in all instances been that of .22 rim-fire. The obvious motive activating the inventive minds which have brought these forth was a desire to adapt the service pistol to indoor use, where a light backstop would serve to halt the missile, the noise of firing be negligible (thus permitting practice in the home basement), and the cost of ammunition so modest that, for all practical purposes, it could be disregarded. Another consideration was the element of recoil—which is practically unfelt when a .22 cartridge is fired from a .45 automatic, the use of the lesser cartridge enabling the beginner to master his weapon without concern as to the "kick"—later to work up to more potent loads.

Obviously, no cartridge, the .45 automatic included, can possess first-class military characteristics plus all the qualities just mentioned. The two would be incompatible. To fulfill its military mission the .45 projectile must develop considerable energy. This would require a relatively stout and expensive backstop to curb its forward progress. This energy means noise sufficient to alarm an entire neighborhood. Further, the production of such a cartridge is too expensive to allow any but the well-to-do, or the home reloader, to indulge promiscuously in its use. Lastly, the recoil is sufficient to disturb the beginner's aim materially—in some instances even to the point of discouragement.

Hence the caliber .22 adaptations, the first of which, as I recall, was one devised by that late master of inventive ingenuity, R. F. Sedgley. This involved an insert barrel, chambered for the .22 long-rifle cartridge, which was slipped into the existing caliber .45 tube, from the muzzle of which its threaded forward end protruded far enough to allow the attachment of a knurled ring, tightening which firmly anchored the whole in position. To permit the original center-fire firing pin to engage the rim of the .22 cartridge and the .45 extractor to function with the .22 case, the insert was bored eccentrically, its lumen parallel to the axis of the larger barrel but slightly displaced to the right. This device involved, during its period of use, the removal of the .45 caliber magazine. Otherwise the pistol remained unchanged.

Next came the Stoeger attachment. This again was a single-shot device, considerably more elaborate than Sedgley's—its use

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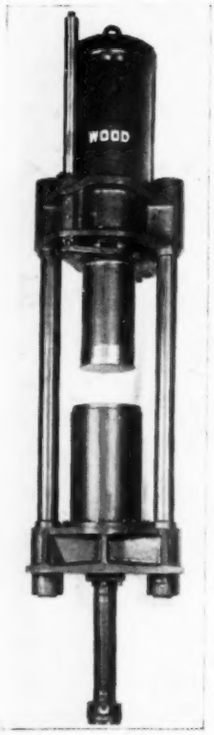

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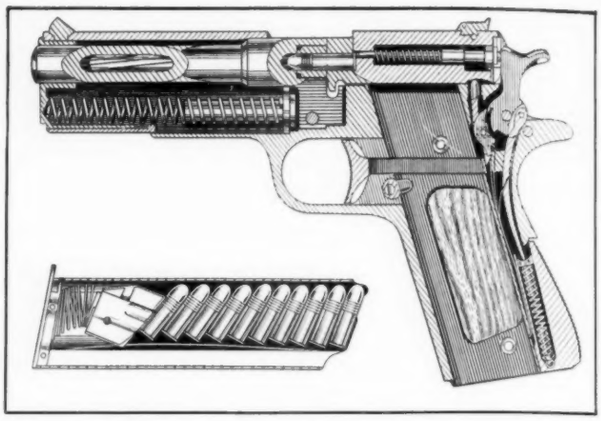
requiring the removal of the original slide, barrel, magazine, plug, bushing, slide stop, recoil spring, and recoil-spring guide, and the attachment in their place of a new slide through which was bored a .22 tube with suitable extractor attached.

BUT these adapters, though serving excellently the purpose for which designed, both suffered from the same fault—they permitted single firing only. Recognizing the desirability of supplying the owner of a .45 automatic with a weapon practically identical in all respects and embodying the desirable features of the caliber .22 as already enumerated, yet capable, like the .45, of sustained rapid fire, the Colt company evolved, some years past, their "Ace" model. This weapon was constructed, as far as possible, of the same components as the larger caliber one, to the same dimensions and approximately the same weight. Indeed, it differed so little from the latter that without glancing into the muzzle or reading the stampings on the slide it was next to impossible for the average shooter to tell one from the other. And it possessed the further advantage of a 10-shot magazine as against a 7-shot capacity for that of the .45.



THE COLT "ACE" SERVICE MODEL AUTOMATIC PISTOL, CAL. .22 LONG RIFLE, WITH MAGAZINE, IN SECTION

But it was not long before a new demand arose. The "Ace" did everything for the shooter but acquaint him with the *recoil* of the .45. Obviously, this acquaintance was in many instances undesirable, for it already has been explained that the novice often can work up gradually to meet the recoil of a heavy caliber and overcome his fear of it by beginning his training with weapons evolving little or no backward push at the breech. Assuming, however, that he already has mastered these and is ready to wrestle with a real "kick," yet lacks the facilities—or the cash—for practice with the heavier-bored arm, what then?

Once more Messrs. Colt rose to the occasion by producing their "floating-chamber" device which, by the ingenious adaptation of fundamental mechanical principles, permits the humble .22 to develop some four times its normal recoil, thus approaching that engendered in the caliber .45 weapon. This is made available to the public in their ".22-45 Conversion Unit" which may be installed on any model 1911 Colt .45 automatic, thus converting it into a caliber .22 weapon of magnified recoil. Or should the prospective buyer not own a .45 but wish a .22 with "pepped-up" recoil, he can purchase one of the "Ace" models with the floating chamber incorporated, and so achieve his objective.

Thus he who would become adept in the use of his national side arm has now available its exact counterpart in caliber .22, either with standard or augmented recoil as preferred. With these he may indulge in practice preliminary to "graduating" to the .45 or at any time after such graduation when circumstances preclude the use of the more powerful weapon.

Book Reviews

THE ART OF MODERN WARFARE. By Col. Hermann Foertsch, German General Staff. Translated by Theodore W. Knauth. New York: The Veritas Press. $2.75.

WHENEVER a really worth-while work on the technical and vastly complicated subject of modern war is presented to the public at a time when it is literally in step with the day's news, it is a treasure to the military student, a delight to the lay reader, and a rare treat for all. Such a work is this soldierly and scholarly book from Germany. Published in Europe but a few months before the present war, the English translation was released on June 15th, and its text now may be checked against the terrific events which are still shaking the entire world and shaping the course of history for America no less than for Europe. Just how vitally needed in our country are the lessons of such a work, all who are cognizant of our past military history, our present unpreparedness, and our future defense needs, will perceive readily.

The arrangement of a book on so many-sided a topic as warfare is an important point. In this case, the author has chosen arrangement by division rather than by continuity. The four quite distinctly separated parts greatly assist in the orderly development of Colonel Foertsch's thought. Part I: "Warfare—Fundamentals and Definitions," consists of forty-four pages devoted to the philosophy of war, strategy and tactics, and morale. The discussion on "Leadership" forms largely an *apologia* for Nazi Germany, but it is in no sense mere propaganda. Indeed, throughout the book, Colonel Foertsch, though he quite naturally writes from the viewpoint of an officer of the Third Reich, is commendably objective and free from bias.

The fifty-eight pages of Part II are devoted to an account of types of wars of the past. The last of these is an excellent résumé of the World War. Written, as it is, from the German viewpoint, it is an aspect seldom seen by the average American reader. This part of the book serves well to connect the theoretical with the factual, orients the reader, and serves as a springboard from which the author leaps into the immense discussion of "Modern Warfare."

Part III comprises some 150 pages. The chapters which deal with the question of the weapons of today are necessarily long, and they have been split into many sections. The author's evaluation of each of the weapons of modern war and its use under modern conditions is excellent. He is free from the narrowness and the overenthusiasms of the specialist, and he holds that on this subject the officer must be progressive in thought, while carefully avoiding the visionary. Though considerations of space hold him to an outline, his succinct style and clear thought result in a very satisfactory picture. He insists on the necessity of the very best in ordnance and in all technical aids, yet he never fails to point to the transcendency of morale.

Part IV, "The Officer," which concludes the book, is but five pages in length, yet in this short space Colonel Foertsch has summarized the very crux of the art of war. He demonstrates conclusively that the officer is both the head and the heart of an army. For though the machine weapon is enormously complicated and powerful, it is still the servant, and the demands on its master, the officer, are greater than ever before.

Colonel Foertsch is thoroughly committed to the attack as the only means with which to force a victorious decision. Events of the past few months prove that in this he truly represents the German High Command. It would be interesting to compare this with the series of books recently edited by Liddell Hart, Britain's greatest exponent of the defensive. One thing is certain—the

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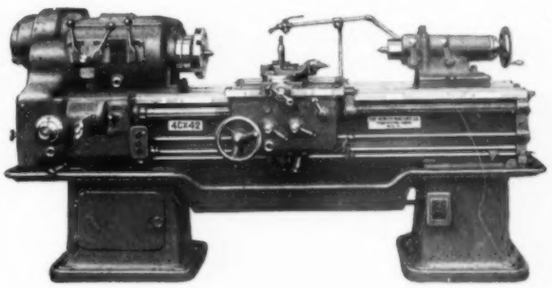

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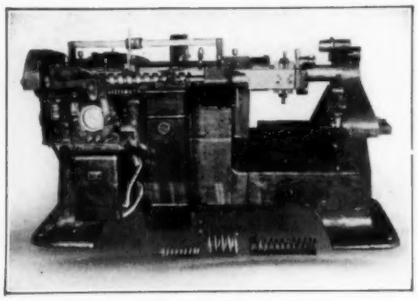

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German High Command holds fast to the tried axioms: "The only way to victory is the destruction of the enemy forces by battle"; and the only way to accomplish this is "the unshakable will to victory in the commander."

One senses throughout the volume, though boasting is conspicuous by its absence, the essential competence of the modern German officer, true coöperation between all arms of the service, and perfect timing by the General Staff. And pervading all, is the complete dominance of the spirit of the attack. Truly, this is compulsory reading for any American who wishes to think straight, hard, and far on the question of our nation's defense.

F. W. F. G.

NOTES ON U. S. ORDNANCE, VOLUME I: SMALL ARMS, 1776-1940. By Capt. James E. Hicks, Mount Vernon, N. Y. $4.50.

THIS book, of 117 quarto pages, 80 plates, and a data table, is the most impressive of the series thus far produced by its prolific author whose "Notes on German Ordnance, 1841-1918," and "Notes on French Ordnance, 1717-1936," offer much useful reference material to the student or collector whose lack of familiarity with foreign languages limits his reading to English sources.

Captain Hicks plainly has made a sincere effort to get at the facts in the history of United States small arms, and has done a good job. Not content with supplying information on standard models, he has gone behind the scenes to ferret out data on experimental types as well, and of these his incomparable illustrator, André Jandot, has supplied sketches in addition to those depicting the better-known and long-catalogued varieties. Indeed, these drawings, of which from three to two-dozen appear on each plate, are alone worth the price of the volume, as is the data table which precedes them and records, with varying degrees of detail, most models of small arms produced for the United States services from 1795 to 1940.

The flood of contract weapons, both long and short (shoulder arm and handgun), which the Government acquired during the Civil War is omitted, perhaps wisely, for a discussion of these can and should fill another volume of the series despite Hicks' suggestion in his foreword that they appear to have been amply treated by earlier authors. But the wisdom of foregoing descriptions of the post-Civil War army and navy models of the caliber .50 Remington single-shot martial pistols, as well as the earlier Elgin (percussion) cutlass pistols (for which he proffers the same explanation) may well be questioned in view of the attention given other contract weapons. The same holds for the Model 1883 Hotchkiss .45-70 repeating rifle as produced by the Winchester Repeating Arms Company, to which but the briefest reference is made, though the 1878 army and the 1879 navy types are both described and illustrated.

The book is made more colorful (the while the reader's search for succinct information is impeded rather than expedited) by the constant inclusion of excerpts from, or the complete texts of, original letters, contracts, etc., bearing upon various phases of our small-arms history.

The only criticism of moment which might be leveled at the present volume concerns, as in the case of earlier works by the same author, the editing. Just why Captain Hicks persists in his refusal to allow competent editors to read his proofs and make necessary corrections, remains a mystery. For by the expenditure of the smallest effort, substantial improvements could have been effected. This aside, he has produced a real and lasting contribution to the literature on American small arms.

C. G.

ROMAN EAGLES OVER ETHIOPIA. By P. A. del Valle. Harrisburg: Military Service Publishing Company. $2.50.

IN this book of 201 pages Colonel del Valle presents an exposition of the Italian campaigns in Ethiopia, beginning with that of Marshal de Bono, followed by that of Marshal Badoglio. Quite

some space also is devoted to the operations conducted by Generals Graziani and Frusci. A perusal of these pages should convince the reader that had the Ethiopians been equipped with modern arms the story might have had quite a different ending.

The greater portion of the Ethiopian equipment was obsolete, and quite a large amount was useless; the Italians were provided with everything a modern army required. The road-building efforts of the Italians deserve high commendation, since roads were in evidence only by their absence when the campaigns began, and the building of modern roads in this terrain was quite a huge task.

The Italian regular infantry is reported to have behaved uniformly well, but the behavior of the Black Shirt (militia) divisions often left a great deal to be desired. The Ethiopians were badly led, but were imbued with a reckless courage which at times threatened disaster to the Italians. These native troops gave an excellent account of themselves in hand-to-hand encounters. With all the odds against them, it is surprising that they were not totally defeated long before the end came; and had they contented themselves with their usual guerrilla tactics, instead of listening to their European instructors and attempting frontal attacks, the end probably would have been a long time in coming. F. H. W.

SEA OF DESTINY. By H. Dyson Carter. New York: Greenberg Publishers, Inc. $3.00.

BECAUSE he did not know geography, King Louis XIV of France signed away his country's rights to Hudson Bay in the Treaty of Utrecht. He thereby paved the way for the loss of all of North America to the English, for Hudson Bay is the military key to the continent—the sea of America's destiny. Yet today it is forgotten again and is wide open, unfortified, ready for invasion. By that invasion Canada can be smashed into helplessness at one blow and the rich industrial cities of the United States exposed to enemy air raids.

Vikings had settled Hudson Bay temporarily some five hundred years before Columbus discovered America, but its recorded history begins with its discovery by Henry Hudson. Thereafter the Bay was explored and fought over by small forces of French and English until 1713, when it finally passed into English hands.

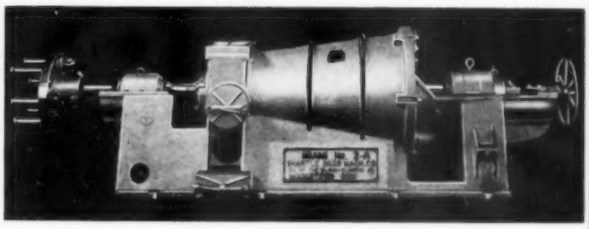
Railroads now have been built to Port Churchill and to Moose Factory, and the Hudson Bay route is coming into its own. Saskatoon is the center of Canada's wheat belt. From this city it is 900 miles by rail to the head of the Great Lakes, then 1,100 miles to Montreal, and an additional 2,900 sea miles to Liverpool. On the other hand, it is 800 miles by rail to Port Churchill, and from there 3,000 miles by sea to Liverpool. Rail and sea journeys are about the same, but the Lakes trip is saved, along with one transshipment! And the navigating season of the Hudson Bay route is longer than that of the Great Lakes.

Meanwhile the storm of Europe's war is spreading, threatening this American Mediterranean. As things now stand, a pocket battleship and some submarines could block Hudson Straits after bringing a convoy in. From this convoy, airplanes could capture and use as bases any of the myriad lakes of Canada's north, raiding American cities as far south as Washington, which is only seven hours by air from Hudson Bay.

This book describes the northern jaw of the pincers, where Gen. Ared White's "Attack on America" describes the southern. J. R. R.

THE GUN COLLECTOR'S HANDBOOK OF VALUES. By Charles E. Chapel. Published by the author at San Leandro, Calif.

CONSTITUTING a suitable companion to Lieutenant Chapel's "Gun Collecting" (Coward-McCann, Inc., New York, 1939), this little work of 16 short chapters (220 pages and 32 plates) should prove a useful reference source to the small-arms collector not sufficiently active in his hobby to be the recipient



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of the sales lists constantly circulated by the major dealers in this commodity. And even should he receive these, he would be forced to the expenditure of no little effort by way of classification and cataloguing ere he could have available, in the handy form in which Chapel presents it, a mass of information comparable to that embodied in the present offering.

Among the author's chief concerns appear to have been the selection of suitable bases for indicating the condition of a "collection piece" and appraising its value. To each of these subjects he devotes a chapter. In the first of these he discusses different types of yardsticks whereby the price at which a piece about to change hands may be determined. He likewise (p. 13) comforts the collector who may feel that he is putting an undue proportion of his funds into weapons, with the statement that "So-called luxury objects . . . are the first to fall in a depression and last to rise, but quality hobby objects, such as fine arms, are sought even more eagerly during hard times. . . ."

Chapel's list of American gunmakers of the flintlock period (pp. 156-159), the most ambitious of its kind since the publication (1924) of Dillin's book "The Kentucky Rifle," includes those noted by Dillin and fully as many more, thereby constituting a most valuable reference source to him who specializes in collecting these distinctively American products.

Chapter IV (pp. 38-44) is devoted to a subject new to most American collectors—the Kentucky flintlock *pistol*, a type produced occasionally as a side line by makers of Kentucky rifles. Here Chapel (or rather Calvin Hetrick who was the first to undertake classification of this group as a separate *species*) has no doubt started something; for the borderline between it and other contemporary American handguns will probably prove intangible, and many and acrimonious will be the discussions as to whether a particular piece is a genuine *Kentucky* pistol or not.

Chapel has had the good luck to secure, from various collectors and dealers, material for the excellent set of plates which illustrate his book. Depicting the majority of the handguns (and some of the shoulder weapons) to be found in most American collections, they serve ably to supplement the subject matter among which they are interspersed. C. G.

S-2 IN ACTION. By Shipley Thomas. Harrisburg: Military Service Publishing Company. $1.50.

EVERY present or future S-2 should certainly feel a high sense of gratitude to Colonel Thomas for his fine presentation of the duties of an S-2 officer. He starts out with advice about selecting his crew of assistants, explaining the duties of each and impressing upon them the necessity for accurate information, or information which must be at hand when preparing orders for attack or defense, in withdrawals or rear-guard actions. The book also explains the equipment and paraphernalia with which each S-2 must provide himself before he goes on his job; in fact nothing seems to be left unsaid, including some personal experiences. The book ends with a chapter of "Don'ts"—very valuable points for any S-2 officer. This little work should be in the hands of all officers interested in military intelligence. F. H. W.

CHEMISTRY IN WARFARE. By F. A. Hessel, M. S. Hessel, and Wellford Martin. New York: Hastings House. $2.00.

SINCE relative viewpoint determines the real value of anything, this book may be considered excellent if one is looking for a simple text for beginners. It is quite comprehensive, its language is simple and interesting, and the pen-and-ink sketches make good illustrations. But the book is not profound, nor does it contain new material. The various types of standard bombs, shells, and propelling mediums are described. The gases described are the ones used in the World War. Other matters treated relate to outline sketches of foods, medicines, and disinfectants. It is a book for new officers who desire to get a quick summary of chemical warfare, rather than for advanced students. G. S. B.